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PACIFIC BASIN STUDY MISSION

REPORT

TO THE

COMMITTEE ON SCIENCE AND TECHNOLOGY U.S. HOUSE OF REPRESENTATIVES

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LETTER OF TRANSMITTAL

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
Washington, D.C., February 2, 1983.

To All Members, Committee on Science and Technology:

There is transmitted herewith a report on the recent study mission to the Pacific Basin and Antarctic conducted during the period January 7 through January 21, 1983.

The purpose of the mission was to meet with members of our counterpart Committee on Science and Technology in the Japanese Diet and to learn more about the science, space, energy and transportation activities and policies in the countries and regions visited.

I commend the report to your attention.

Sincerely,

DON FUQUA, *Chairman.*

LETTER OF SUBMITTAL

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
Washington, D.C., February 2, 1983.

Hon. DON FUQUA,
Chairman, Committee on Science and Technology, U.S. House of Representatives, Washington, D.C.

DEAR MR. CHAIRMAN: I am sending you this report on the study mission to the Antarctic, New Zealand, Australia and Japan conducted between January 7 and January 21, 1983. The report includes summaries and discussions of each meeting and facility visit, as well as a summary of the three meetings held with the Members of the Japanese Diet who serve on the Committee on Science and Technology.

On your instructions, the Committee developed a plan to conduct a review of as many space, energy, science, and transportation facilities as time permitted. The schedule was designed to give Members and staff a firsthand opportunity to exchange views with the Diet Members on matters of mutual interest, as well as to assess the status and performance of our allies in the Pacific Basin in the areas of energy technology development, space applications, including communications, and in the area of science policy and science programs.

The study mission and accompanying report were organized and coordinated by Rob Ketcham, the General Counsel.

Sincerely,

J. H. POORE,
Executive Director.

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COMMITTEE MEETINGS

U.S. Antarctic Research Programs

Location: Antarctica (McMurdo Station and the South Pole Station).
Date: January 11, 12, 1983.

SUMMARY

The delegation visited the research stations at McMurdo and South Pole in the Antarctic.

DISCUSSION

The continent known as Antarctica is a complex problem for the nations of the world. It comprises approximately 10 percent of the world's land area, even though most of it is covered with ice up to two miles thick. Sovereignty over the continent is an unresolved issue. Seven nations have claimed parts of the continent but, these claims are weak and are unrecognized by most nations. Three of them actually overlap substantially.

Prior to the enactment of the Antarctic Treaty this was a source of some friction among the claimants and, in the event the Antarctic Treaty should become ineffective, it could lead to future international discord.

The attached article by Dr. Thomas O. Jones, a former director of the United States Antarctic Research Program, recounts some of the history of the cooperation in polar scientific research that in the International Geophysical Year set the stage for the Treaty, proposed by the United States in 1958 and which entered into force in 1961. The Treaty accomplishes three significant things:

(1) Defuses tension over the claims issue during the life of the Treaty.

(2) Effectively de-militarizes the continent, and

(3) Provides for free and open access to all parts of the continent for peaceful purposes.

The resources of the continent are largely a matter of speculation at the present time. Some exploitation of marine living resources, primarily whales and seals, has gone on for the past century. Overexploitation eventually lead to conservation measures such as the International Whaling Convention (IWC) and the Convention for the Conservation of Antarctic Seals.

More recently, exploratory fishing for antarctic fin fish and for a tiny crustacean, Euphousia Superba—commonly known as krill—which is a basic food source for fish, seals, whales and penguins—has begun by several nations. In recognition, the nations party to the Antarctic Treaty, concluded in 1981 a Convention for the Conservation of Antarctic Marine Living Resources. In preparation for the time in

the distant future when Antarctic mineral resources might become known and economical to exploit, these nations are actively negotiating another agreement to provide for rational decisionmaking and control of such exploitation.

In the long run, however, the primary benefit to be derived by mankind from the continent is apt to be the results of years of painstaking scientific research that, bit-by-bit, pieces together a mosaic of understanding of the role of the polar regions in governing the environment or climate of the world. The major areas in which most of the research must be done in Antarctica include oceanography, geology, geophysics, marine biology, glaciology, and the atmospheric sciences.

In their influence upon the oceans, the weather, and the world's climate both polar regions are important, but the differences in the geographical configurations of the two regions are such that the Antarctic probably has the more significant impact.

The Antarctic Treaty was initially proposed by the United States and it has been long-standing U.S. policy to lend strong support to making the treaty effective. It has also been long-standing U.S. policy that the U.S. presence in Antarctica shall be influential and solidly based on a balanced program of scientific research. For this reason, the conduct of the U.S. program in Antarctica has been assigned to the National Science Foundation to be operated under the general guidance of relevant Presidential directives the most recent of which was issued by the President on February 5, 1982. Overall administration development of policy with respect to Antarctic issues is assisted by the multi-agency Antarctic Policy Group (APG) chaired by the Department of State.

In the House of Representatives, legislative and oversight responsibilities for the National Science Foundation and its programs is under the jurisdiction of the Committee on Science and Technology. In recognition of the unique nature of the U.S. Antarctic Program within the broader NSF mission, Chairman Fuqua led a small group on an inspection program. The delegation visited the main logistics support base at McMurdo (see map on page 3) and the remote outpost at the South Pole itself. The group interviewed a number of the scientists from U.S. universities who are conducting research projects at these two stations. They also inspected the logistic support activities of the U.S. Navy (Naval Support Force, Antarctica and the UXE–G Air Squadron), the United States Coast Guard (icebreakers U.S.-C.G.C. Polar Star and Glacier), and of the civilian contractor (Antarctic Services, Inc. of the Federal Electric Corporation, a subsidiary of International Telephone and Telegraph).

The appendix includes a brief description of each project currently funded by the National Science Foundation in the Antarctic and also one project supported by NOAA. The delegation visited the laboratories and spoke to researchers in the following projects:

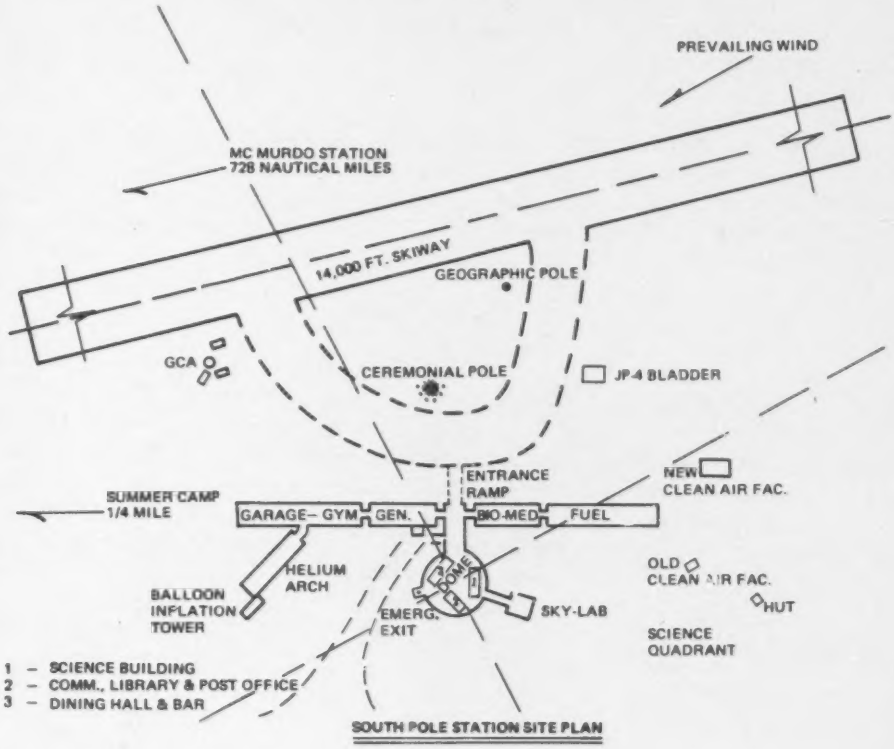
(1) Lake Physiology Adaptations;

(2) The role of Glycopeptide Antifreezes and freezing avoidance of Antarctic fish;

(3) Endolithic micro-organisms and ice free valleys: primary producers in the Antarctic desert ecosystem;

(4) Factors influencing the growth and development of sea/ice microbial communities;

(5) Cosmic ray intensity variations;
(6) Human immune responses during bio-isolation;
(7) Long period gravity and observations;
(8) Atmospheric infrasound studies; and
(9) The geophysical monitoring for climatic change (NOAA).



SOUTH POLE STATION SITE PLAN

Tour of Motonui Synthetic Fuels Plant and Energy Briefing

Location: New Plymouth, New Zealand.
Date: January 10, 1982.

SUMMARY

The delegation was briefed and toured the site of the synthetic fuels plant, which is under construction at Motonui. Following the tour a round table discussion took place with representatives of the New Zealand Synthetic Fuels Corporations Ltd. (NZSFCL) and other energy related industries in New Zealand.

DISCUSSION

Prior to the oil embargo of 1973, New Zealand was dependent on oil imports for 100 percent of its petroleum consumption. More than 50 percent of petroleum demand was in the transportation sector; the industrial, home heating, and electric sectors consumed the remaining oil. In the mid 1960's, a substantial natural gas field was discovered some 30 miles off shore in the Maui field; the resources were estimated to be some 10–12 trillion cubic feet (TCF). Although this is small by U.S. standards (Annual gas consumption in the United States is about 21 TCF.)) it is a 60 year supply of natural gas for New Zealand even taking into account increased use for gasoline and methanol production. However, prior to the oil embargo and the subsequent doubling of the price of oil, it was not economic to develop the Maui field.

The oil embargo made it imperative for New Zealand to reduce its oil imports. They established a goal of 50 percent oil imports. The primary target for change was the transportation sector. The strategy by which this was to be accomplished was threefold: First, natural gas from the Maui field would be converted into synthetic gasoline; this would provide 33 percent of gasoline requirements. Second, the liquid condensates associated with the natural gas would be processed into gasoline and add another 7 percent. Finally, a substantial portion of the nation's automobile fleet would be converted to use compressed natural gas (CNG) with a dual fuel capability for gasoline. To accomplish the first two parts of the strategy, the New Zealand government established the New Zealand Synthetic Fuels Corporation Limited. The conversion of automobiles to compressed natural gas required a government subsidy to mitigate the costs of the CNG conversion equipment.

The decision to utilize the Mobil methanol-to-gasoline process was a result of its high efficiency in converting methanol to gasoline rather than to a full span of hydrocarbon products.

History of the Motonui Project

The New Zealand government approached Mobil Corporation in 1979 to investigate the application of its methanol-to-gasoline process using a zeolite shape selective catalyst. The process was tested at

Mobil's Paulsboro, New Jersey pilot plant. In 1980 a memorandum of understanding was signed between the government of New Zealand and Mobil Corporation, with each contributing $25 million for a feasibility study for the project. In 1981 the joint venture, New Zealand Synthetic Fuels Corporation Limited, was established by the government of New Zealand and the Mobil Corporation; the government's share was 75 percent with Mobil having 25 percent of the equity. On March 12, 1982, construction was begun with completion expected about the end of 1984. Mobil Corporation was to construct and operate the plant for the joint venture.

The plant will produce 14,800 barrels per day of gasoline using a feed of 80 million cubic feet of natural gas per day. The natural gas will first be converted to methanol using the ICI process; it will be the largest single methanol plant in the world producing some 4400 tons per day of methanol. It will contain five Mobil methanol-to-gas reactors with four operating at any one time. These are fixed bed reactors and thus one will continually be out of operation for regeneration and recycling of the catalyst. Mobil provides the catalyst, which is produced in Beaumont, Texas. The plant will produce gasoline at a cost of 30 cents per liter with a 93 octane rating without lead. This will permit the government to cut the lead content of gasoline in its refineries. The plant will require approximately 16 percent of the Maui field production over the next 30 years.

Project financing

With design 90 percent complete, the estimated cost of the project in 1980 U.S. dollars is $767 million plus or minus 10 percent. In as built dollars this amounts to $1.245 billion. At this moment the project is 7 percent complete and is on schedule and on budget. The project is 80 percent debt financed with the remaining $265 million being provided by the NZSFCL. The debt portion includes a $1.2 billion Eurodollar loan and a standby loan of $.5 billion to cover unexpected costs. The loan was arranged by a consortium of banks led by Citicorp. It is the largest loan in the Pacific area. When compared to New Zealand's GDP of approximately $23 billion in 1981, this represents a considerable exposure for the nation. A comparable exposure for the United States is around $50 billion.

Socioeconomic impacts

The New Zealand government has responsibility for financing the major portion of socioeconomic impacts: i.e. roads, hospitals, schools, other social services. The National Development Act of 1981 provides that .5 percent of the capital cost of major development projects can be allocated to mitigate socioeconomic impacts. The mechanism for the estimate of capital costs and the timing of disbursement is unclear in the legislation and leaves considerable latitude for negotiation between the State and the local governments. The NZSFCL has responsibility for taking care of the housing and environmental impacts within the boundaries of the plant itself. The corporation has a $20–30 million dollar program to provide residences for the construction and operating personnel. Currently they have built some 360 houses for the supervisory personnel associated with the construction of the plant. In addition they have purchased a motel and are expanding it to provide

single status accommodation for 110 to 440 people. The peak construction force is expected to be between 1600 and 1800 people. The peak will come between the end of 1983 and early 1984. The operating force is expected to be approximately 300 people. The only trades that cannot be provided by the indigenous New Zealand labor force are electricians and instrument installers. It is expected that some 90 people will be brought from Australia during the period of construction. In the case of pipe fitters and welders, they can be trained on site and the local Polytechnic Institute has developed a special training program.

Other issues

The discussion with the representatives of Petrocorp and Petralgas put the efforts of the New Zealanders in synthetic fuels into the overall context of their fossil energy development activities. Petrocorp is the Petroleum Corporation of New Zealand, Limited. It was formed as a holding company in 1978 to provide for the prudent use of New Zealand's oil and gas resources. It is a limited liability company which was incorporated by the government with all its shares being held by the government. It has four wholly-owned subsidiary companies. In addition, it owns 51 percent of Petralgas Chemicals NZ Limited; the remaining 49 percent is owned by Alberta Gas of Canada. This company was established to produce chemical grade methanol and ammonia urea for fertilizers from the natural gas in the Maui field. The overall role of Petrocorp involves the exploration for oil and gas both on shore and off shore, the development and production of New Zealand oil and gas resources, the distribution of natural gas, the production and distribution of liquified petroleum gas (LPG) and the development of the New Zealand petrochemical industry. Thus, it is the operator of the Maui field and as such provides the natural gas to the Motonui project, and it will also be the owner and distributor of the product gasoline.

As the natural gas distribution company, Petrocorp is very involved in the conversion of the automobile fleet to compressed natural gas. Its target is the conversion of 200,000 vehicles by 1990. Currently some 30,000 vehicles have been converted. The first targets are government and private vehicle fleets. There is an approximately 2–3 year amortization of the conversion kit price. The conversion provides a range of 60–90 miles on CNG. There has been a consumer lag that is primarily due to a lack of stations providing the fuel and the need not only to provide the tanks and dual fuel capability but also the requirement to adjust the spark timing so that the cars can operate on compressed natural gas.

Briefing and Tour of Wairakei Geothermal Power Station

Location: Taupo, New Zealand.
Date: January 10, 1983.

SUMMARY

The delegation received a briefing on the geothermal resources of New Zealand and a tour of the Wairakei facility.

DISCUSSION

The main geothermal region of New Zealand is 150 miles long and 20 miles wide. It stretches from three active volcanos Ruapehu, Ngauruhoe, and Tongariro in the center of the North Island, to another active volcano on White Island in the Bay of Plenty off the northern coast. Underground activity along this belt shows itself on the surface in several localities as fumeroles, geysers, mud pools, and hot springs. Wairakei geothermal station is near the center of this thermal region. The generating station is sited beside the Waikato River, 10 kilometers from Taupo, and uses steam in wells drilled in the nearby Waiora Valley.

Modern use of these resources was first discussed in the 1930's and investigations in 1940 showed that the best use of this energy would be to generate electricity. In 1949 the government of New Zealand approved a five year investigation program to be carried out by the Department of Scientific and Industrial Research in the region near Wairakei. The results were promising and the drilling program was begun to obtain steam equivalent for 20 megawatts of electricity. In 1953, a proposal was made to establish a 53 MW power station. About this time the United Kingdom Atomic Energy Authority became interested in geothermal heat for the production of heavy water by distillation, so a joint project was established producing heavy water and generating electricity was planned. In 1956, however, the United Kingdom withdrew and in place of the distillation plant, the generating capacity was raised to 69 MW. The first generator was commissioned in November 1958. By 1963, the total installed capacity was rated at 192.6 megawatts.

The geothermal steam at Wairakei is quite wet. The volume ratio of water to steam is 4 to 1. Without some kind of heat recovery in the form of cogeneration or district heating, the efficiency of electric power generation is only 8 percent. The steam temperature is about 200°C. This is only a moderate temperature resource. The steam is produced by direct separation and then flashing the remaining hot water. The reject water, which is piped to the Waikato River enters at a temperature of about 88°C. It is highly mineralized and combined with the thermal pollution has had deleterious effects on the river fauna. New Zealand is planning to reinject the waste water. This is similar to the plans being made by the Mexican government for its

geothermal installations at Cerro Prieto. Another reason for reinjecting the water is to maintain the pressure head in the wells. Since initial operation, many of the wells have lost pressure; however, with the introduction of higher efficiency turbines, there has been a net trade off and the power plants have not been derated.

New Zealand expects to install additional geothermal electric capacity in the next 10–20 years. North of Wairakei, least another 250 megawatts of capacity will be installed. At present more than 90 percent of New Zealand's electricity on both the North and South Island is generated by hydroelectric stations. Geothermal resources contribute about 4 percent of the capacity. The remaining capacity is peaking capacity running on oil or gas; the coal fired generation capacity is very small.

EMBASSY BRIEFING—NEW ZEALAND

Location: Wellington, New Zealand.
Date: January 11, 1983.

SUMMARY

Ambassador Brown and key members of the American Embassy staff briefed the delegation on conditions in New Zealand. The major topics were the ANZUS Treaty, the economy, foreign policy and New Zealand politics.

DISCUSSION

The ANZUS security treaty was signed by representatives of Australia, New Zealand and the United States on September 1, 1951. It binds the signatories to recognize that an armed attack in the Pacific area on any of them would be a danger to the peace and safety of the other two and commits them to consult and to meet the common danger in accordance with their respective constitutional processes.

The treaty establishes a Council of Foreign Ministers that meets annually to consider matters concerning its implementation. The ANZUS Council is supplemented by consultations between the U.S. Commander-in-Chief Pacific and the chiefs of staff of the Australian and New Zealand armed forces. There are also regular ANZUS intelligence consultations and meetings of the officials of the three governments on a variety of topics. The most recent ANZUS Council meeting, the 31st session, was held in Canberry, June 21–22, 1982. The 32nd session is scheduled for Washington, D.C., on July 18–19, 1983.

In fulfillment of their ANZUS obligations, the three parties conduct a variety of joint activities. These include regularly scheduled military exercises ranging from naval and landing exercises on the task group level to battalion-level specific forces training. In addition, the allies assign officers to each other's armed services, seek to standardize equipment and operational doctrine, and cooperate in a variety of other important projects. Among these are the security facilities constructed by the U.S. in Australia and operated jointly by the two countries.

Ambassador Brown stated his view that the ANZUS Treaty is one of our more solid arrangements with allies.

The New Zealand economy has been beset by a host of economic ills over the past decade. High unemployment, rising inflation, increasing energy costs and low wages continue to plague the government, which has had to resort to extensive borrowing in order to make up for revenue shortfalls. Because over 70 percent of its export earnings are based on agricultural exports—beef, mutton, wool and dairy products—the terms of international trade for New Zealand have declined over the last decade.

The United States ranks second after Australia as New Zealand's principal trading partner. The two-way trade last year amounted to $1.5 billion. Approximately 25 percent of the beef imported into the

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United States comes from New Zealand. In the past New Zealand was content to supply dairy and meat products to the United Kingdom; but when the U.K. joined the common Market, this market was greatly diminished. Whereas the U.K. accounted for 90 percent of New Zealand's exports, it now receives only 10 percent. Instead, New Zealand exports extensively to Australia, the United States and Japan.

New Zealand is highly efficient at producing dairy products, beef, and wool. Beef, however, is expensive to the point of being non-competitive because of high processing costs attributable to resistance to automation.

New Zealand's long-term economic prospects are more sanguine than the short-term outlook, and some improvement should be apparent by the mid-1980's when forestry and fisheries should be making greater contributions to the economy. More importantly, New Zealand's energy picture should be greatly improved by products connected with its large natural gas fields (see discussion on Motonui Synthetic Gasoline Plant).

Relations between the United States and New Zealand are very good. Our differences are few. Among these are the Law of the Sea Treaty which the New Zealand government had hoped the United States would have signed. The United States looks to New Zealand as an important intermediary in our relations with the South Pacific Islands. New Zealand sends most of its modest foreign aid to these areas. It has good relations with the Pacific rim countries.

The United States is trying to encourage stronger business ties between New Zealand and Australia believing that this will increase our trade with Asian countries generally over the long term. This could be significant since our trade with the ASEAN countries already exceeds that with West Europe.

Politically, the majority National Party achieved only a one seat advantage in the unicameral legislature in last year's election. In spite of this, they have been able to form a cabinet and govern.

With regard to the military situation, New Zealand has a modest military budget supporting about 10,000 ground troops. The government recently purchased 2 frigates from the U.K. These will give the Navy a blue water capability for the first time. The Air Force has a squadron of A–4's which will be replaced over the next few years with modern aircraft such as the A–1, F–SG, F–16 or F–18. The government must secure long-term financing to achieve this modernization.

Discussions With W. J. Falconer, Deputy Secretary of Energy and Others

Location: Wellington, New Zealand
Date: January 11, 1983

SUMMARY

Discussions with Mr. William Falconer, Deputy Secretary of Energy, Mr. David C. Forsyth, Dr. H. E. Bauer, Ministry of Energy and Dr. I.R.C. McDonald, Department of Scientific and Industrial Research.

DISCUSSION

The discussion focused on three main areas: organization of the government to perform energy programs, nonconventional or alternative fuels and the natural gas-to-gasoline Synthetic Fuels Corporation project. Mr. Falconer noted that New Zealand's energy policy must cover a full spectrum of options. They can't depend, of course, on their neighbors in the Pacific, and at the same time their resources limit them to selecting certain high priority areas. They feel they have a relatively high profile in terms of an energy program internationally and trust that they have made modest progress.

Dr. McDonald of the Department of Scientific and Industrial Research (DSIR) briefly discussed the earlier activities of the organization after its founding in 1926 when it first worked in the agricultural research area. Shortly thereafter, DSIR did coal studies and then cut back significantly on coal work after they decided coal would not be a useful resource (about 1950). That is about the same time when the decision was made to go ahead with the geothermal fuels at Wyracki. The biggest hole there is 25 megawatts which is not quite as large as certain other geothermal resources. Dr. McDonald pointed out that recently they had done consulting in the geothermal area for other countries. The electrical department and the DSIR did nuclear studies in the 1960's and 1970's and reached the conclusion in 1976 that, at least for the time being, they would not pursue the nuclear option. The Energy R&D Corporation was discussed. The funding by this entity is part of the overall energy R&D funding with other sources being the Department of Industrial and Scientific Research and the Synthetic Fuels Corporation itself. The overall budget in the energy ministry DSIR, etc. for the period 1981–1982 was roughly $17 million. The Liquid Fuels Board provides a couple of million of that through a $\frac{1}{10}$ cent per litre tax on gasoline. The officials also recounted how the government had made the decision not to pursue direct liquefaction, they didn't feel it would work economically. DSIR has funded catalytic research and they are spending roughly $5–6 million a year overall in energy, which is roughly $\frac{1}{3}$ of the total energy R&D budget.

There was then a brief discussion of the New Zealand Synfuels Corporation project for which Falconer pointed out the breakeven oil

price for the project would be $15 per barrel. That is the point at which the New Zealand taxpayer would have to "dig into his pockets" to support the project. The Ministry of Energy feels that in terms of electrical needs they may have to pursue nuclear some day, even though it is on hold at the moment. All the officials have made it clear that they keep informed on what is happening in energy programs and policy internationally.

The discussion turned to the second item, nonconventional fuels. Dr. Bauer noted that 50 percent of their R. & D. dollars go to coal, 30 percent for conservation, 15 percent for geothermal, and roughly 5 percent for biomass. As for liquid fuel use the average vehicle turnover period in New Zealand is 10 years. They have encouraged change over to methanol fuel. Some solar work was carried on by DSIR. They did testing to verify hot water heating concepts; the government offers low interest loans for such devices. They restricted the overall activity on wind energy to surveys and decided it doesn't look economic; one of the reasons is that their hydroelectricity is relatively cheap, incremental cost for new hydroelectricity is roughly 3.5 cents per kilowatt hour. The existing hydroelectric system cost is roughly 2 cents per kilowatt. Small hydro projects are carried on by localities where they build up to 25 megawatt projects themselves. The states get loans from the government for hydro and there does not seem to be a tight federal permitting role in these states and local projects. The large hydro projects now being proposed have run into increasing environmental opposition and, although most of the dams built in the past years by the New Zealand government have been reliable, two dams in the same area of the country had failed and this aggravates the environmental and safety questions about dams.

The New Zealanders discussed a planning council approach to consolidate concerns about a project so that decisions could be reached on what amounts to environmental permitting. They noted that there are two ways to approach this through the National Development Act of 1981 or under previously existing law. They noted in the case of an open pit mine where they faced strong opposition, they had actually withdrawn the government's request, and in another instance recently the government's request, and in another instance recently the legislature overruled the planning tribunal decision that the project should not go ahead. This was done under the previously existing law, and there was not any detailed discussion of what the differences are between the two approaches. In terms of infrastructure support, it was noted that about 10 percent of the capital costs of the SFC project goes for bridges, roads, and other community support. There has been considerable discussion between the government and the localities as to whether the amount of infrastructure support for project funding should be based on need or value. The localities pressed for the value basis, but the government has contended that the plant is of no value to anyone but the government and that support should be based on local need. The time at which firm estimates of capital costs can be made is important in terms of the local governments receiving up-front money.

The final discussion was on the synthetic fuels activity, particularly the natural gas-to-gasoline project. There was somewhat detailed discussion on the manner in which the project is being funded by non-

secured loans and precisely as to what the government and Mobil's stake is in the project. It appears that the government has made what is effectively a purchase agreement such that they will provide backing for the project independent of the world price of oil. The eighteen year contract for operation of the plan calls for providing the natural gas at a relatively low price today. In other words, the natural gas feedstock cost is independent of inflation and other circumstances for the useful life of the plant. The SFC official, Mr. Forsyth, noted that they have a 16% tax paid on the project, presumably this means that the project has a 16% tax credit and although we had been told that Mobil has 25% of the project, they pointed out that the equity ratio is 80/20 and Mobil is cost-sharing 25% of the 20%. This amounts to really only having 5% of the action.

In this context, there was a brief discussion of Compressed National Gas (CNG), where New Zealand has had a program to encourage use and presently 25,000 to 30,000 automobiles have switched to CNG and the target is to increase this significantly. The Energy Ministry's view of having to get liquid fuels from coal is the same as their view about using nuclear fuel, time is on their side. They have considerable time before they have to come make a choice. Mr. Falconer asked the delegation what the prospects were for nuclear energy in the United States, and there was a general discussion on this question. Various aspects of the Ministry's energy plan are discussed in the appendix.

Inspection, Tour and Briefing on the Glomar Challenger

Location: Wellington, New Zealand.
Date: January 11, 1983.

SUMMARY

The Glomar Challenger, a project research vessel under contract to the National Science Foundation (NSF) was in port for a crew change and new supplies, and therefore available so that the Committee and staff were able to go aboard for a briefing and inspection tour.

The NSF project leader, Dr. Archie MacLarean, and the Scripps Institution of Oceanography's Dr. Mel Peterson conducted the briefing and tour.

DISCUSSION

The Glomar Challenger is owned by Global Marine, Inc., of Los Angeles, California. It is used by the National Science Foundation as part of the Deep Sea Drilling Project (DSDP) which is funded as part of the Foundation's Ocean Sediment Coring Program. The prime contract for the management of the project is between NSF and the University of California, with the Scripps Institution of Oceanography in San Diego delegated the management responsibility.

The Deep Sea Drilling Project (DSDP) is a unique effort to increase man's knowledge of the Earth, the age, history and processes of development of the ocean basins and the structure and composition of the oceanic crust. An equally important aspect is the increase in the information DSDP has made available to the world's scientific community—and, ultimately, to the public at large—concerning the resource potential of vast realms of the earth.

To that end, the Project has developed a library of over 26 miles of sediment cores collected from drill holes in nearly every major ocean basin. This fund of knowledge provides a resource for study of the past history of the oceans, the rifting and separation of continents, generation and destruction of ocean basins, interaction of changing ocean currents and climate and the evolution of fauna and flora.

The project began in 1967 and the Challenger began its first program of ocean drilling on August 11, 1968. This ocean sediment coring program has proved most valuable in gaining a better understanding of how new ocean crust is formed and destroyed. The benefit from such knowledge is better information on the formation of minerals and understanding of the fundamental process that control the shaping of the earth's surface. For example, it has been learned that oxygen hasn't always been circulated to the bottom of the ocean floor, and that some 90,000,000 years ago oxygen circulation was reduced in some places.

The Glomar Challenger is a dynamically positioned ship which can drill in very deep water. To this end it has successfully drilled in 23,000 feet of water. Project engineers must be accorded much credit for these

accomplishments. Up to 16 scientists can be accommodated on the ship at any one time.

Among the engineering breakthroughs is computer controlled dynamic positioning which system keeps the *Challenger* over the bore hole in mid-ocean. The ship's position must be precisely maintained and an equally precise and reliable system had to be developed to meet those standards. Dynamic positioning is now a relatively common equipment system aboard drilling ships the world over.

As part of the project's evolution the Committee was told about the challenges met by the program in overcoming drilling in rock that was too hard for the drill bits. Another very significant development has been the project's successful system for re-entry of holes previously drilled—described by Dr. Peterson as dropping a piano wire from the top of the Empire State Building into a coke bottle.

By the end of 1970, project engineers developed a re-entry system so that scientists could bring the worn bit to the surface, replace it and then re-enter the same hole and continue deeper into the seabed. A keystone of the system is the re-entry cone, a steel funnel some 16-feet in diameter equipped with sonar reflectors, and side scanning sonar by which the drill string is guided into the hole, in full oceanic depths.

A new technique in core recovery has also been developed, to replace the old rotary coring process. A hydralic piston coring process is combined with rotary coring, taken to a certain depth, and then followed by new coring.

Approximately 65 percent of the project funding is by the United States. At the present time four other countries contribute $2,000,000 each to the program each year, West Germany, the United Kingdom, France, and Japan. Until recently, the U.S.S.R. was also a contributor, but the arrangement was terminated by the U.S. government after the Polish incidents protested by the United States. At the present time the NSF is seeking other contributors to make up the shortfall and are talking with the Australian and New Zealand governments. The shortfall has delayed the recording of data, according to Dr. Peterson.

The project received approximately $21 million in 1981, $22 million in 1982, and $14 million in 1983. The present capability of the ship has been reached, and attention is now being paid to an upgrading of the systems on the ship, or utilizing a different ship for the program, the Glomar Explorer, which is presently in drydock, was built 5 years later, and has a 112 foot beam and 619 foot length, as related to the Challenger with a 65 foot beam and 400 foot length.

Upwards of $10 million would be required to upgrade the Challenger. The heave compensator system needs replacement, as do the ship's generators, and the dynamic positioning system needs upgrading.

Embassy Briefing—Australia

Location: Sydney, Australia.
Date: January 14, 1983.

SUMMARY

United States-Australia relations were characterized as a full, equal partnership. The United States is prepared to work with any elected government. Australia's current economic conditions are not satisfactory and improvements are not forecasted for the near future. The six American bases in Australia are for purposess of research and communications and all are operated as joint facilities.

DISCUSSION

Charge' Steven Lyne advised that relations between the Australians and the United States are very close. The key to this relationship is complete cooperation on both economic and military affairs and on a full, equal partnership basis. He announced that Prime Minister Frazier will meet with President Reagan in May 1983 for a broadbased discussion. This will follow a similar consultation in June 1982. The United States is prepared to work with any elected government and avoids partisan political participation.

Public Affairs Officer, Ivan Klecka, discussed press policy. He reiterated the point that the Australian and the United States relationship is a joint partnership. The six American basess in Australia are used for research and communications purposes and are jointly operated. The Australian government will celebrate their bicentennial in 1988. Australia participated in America's 1976 Bicentennial and we intend to reciprocate in 1988.

Economic Counselor, Paul Laase discussed the economic situation in Australia. He advised that there are tremendous resources in Australia: 25% of the world's uranium, second ranking in total coal, large offshore natural gas resources, and the largest brown coal deposits in the world. Maps of these resources are included as an appendix to this report. He said that agriculture operated very efficiently but that manufacturing was extremely protected. For example, the automobile industry is protected to over 100 percent of value, which means that an automobile brought into Australia would cost more than twice as much as the same automobile manufactured in Australia. The current economic situation shows a 12 percent inflation rate, flat National Economic growth, 9 percent unemployment (whereas 3 percent was formally considered maximum), an expanding deficit, a deteriorating trade balance, and high interest rates (15 percent for home mortgage, 18 percent for industrial borrowing).

Unionism in Australia is widely practiced. Sixty percent of industrial employees are unionized into 300 recognized unions. This has lead to a high degree of specialization. For instance, there are 37 unions in-

volved in all phases of coal extraction, transportation, handling, and loading for export. There are 23 unions involved in general seaport operation.

There is no sign of economic improvement in the near future. In addition, agricultural production is considerably decreased due to a drought which has continued over the past 4 years. In an attempt to decrease the deficit the Australian government has imposed an income tax rate that ranges from 32 percent to 60 percent, with sales taxes in addition. There is also a current wage freeze.

Defense Attache, Colonel Jim Rider, discussed the defense position of the Australian government. Approximately 3 percent of the national product is used for defense, which amounts to $4.5 billion per year. There are 73,000 men in uniform and the active reserve totals 33,000. The national logistics are restrained somewhat in that there is no continuous north to south transportation capability extending the entire width of the continent.

The United States maintains no combat troops in Australia. There are 800 people engaged in research and communications at six locations. There are joint military exercises with the Australians in both Hawaii and northeastern Australia. The United States was offered a port for our use following the invasion of Afghanistan.

CSR Energy Research Briefing

Location: Sydney, Australia.
Date: January 14, 1983.

SUMMARY

CSR is an Australian corporate entity which was founded in 1855. The corporation is active in sugar production, energy extraction and production, aluminum and chemicals, minerals, and building materials. They spend about $45 million per year on energy exploration and research. The 1982 annual report is included as an appendix to this report, as are reports on oil shale, oil and gas, and coal.

DISCUSSION

The corporation was founded in 1855 as Colonial Sugar Refining, Ltd., an Australian sugar refiner. As the corporation expanded, they used the bagasse (extracted sugar cane) to fabricate building materials. Although they later utilized bagasse as a boiler fuel, they continued and expanded in the building materials industry. They have incorporated a number of materials improvements through agreements with the United States on various technologies. Next, they obtained significant deposits of iron ore and bauxite to inaugurate a minerals division. They became active in coal in the early 1970's and now produce at the rate of 9 million tons per year. They estimate their total coal reserves at 6 billion tons. They became active in oil and gas exploration in the late 1970's. In 1981 they acquired Delhi Petroleum whose principal activities are in the Cooper and Eromanga basins in South Australia and Queensland.

Assistant General Manager, E. F. Herbert discussed the CSR research overview. He said that Australia needs heavy end crudes and imports primarily from Saudia Arabia, Indonesia, and Kuwait. He characterized Australia more "gas prone than oil prone." He said that his company expects Australia coal to grow at an export rate of 8 percent per year. He says that Australia also will export compressed natural gas and liquified natural gas in the not too distant future. He does not see the possibility of converting this natural gas to gasoline, as does New Zealand. For logistical reasons, they need heavy ends rather than light distillates in Australia. Speaking for the CSR, Herbert said that they give oil shale a greater priority than petroleum in the future to meet Australia's liquid energy demands.

He then discussed uranium enrichment and the evaluations they have made of the various processes being offered. He said gaseous diffusion is too expensive and was given no further consideration. The French technology was rejected as an untried process which would make CSR "the first guinea pig." Comparing the URENCO and U.S. centrifuge processes, he made the following distinction. Tentatively,

CSR has chosen URENCO because it is commercially proven, it is smaller in size per module and they wish to emphasize modularity, and the philosophy is that you run a small centrifuge to destruction. On the other hand, he said the larger centrifuges offered by the United States required greater initial capital. This would be minimized by processing 8 million SWU per year. However, he said that Australia is interested in a 12 million SWU capability. He claimed that the American process is not as advanced as URENCO. He also said that their market research to date did not indicate that the United States would be a lucrative enrichment market, that Japan and Europe looked much better. CSR is presently making a detailed evaluation of the market potential for uranium enrichment.

CSR became involved in uranium with the discovery of a significant deposit in 1972. It is estimated that the reserve is 3,400 tons of U_3O_8 at an average ore grade of 0.157 percent U_3O_8.

CSR is currently funding energy exploration and research at the annual rate of $45 million. Their work is primarily exploration. Their research activities primarily consist of monitoring programs of other national governments.

V. G. Swindon, General Manager, Oil and Gas Division, discussed the CSR activity in oil and gas. He said that CSR has the largest group of employees, numbering about 200, of any Australian energy firm. However, he believes that this group is not sufficiently large to maintain a basic research program. Therefore, their major activity is application of known technologies.

Robin Holdgate, Manager, Oil Shale Division, provided information on CSR oil shale programs. Their major project is at Julia Creek, in central Queensland. Investigation of this resource has proceeded in a one-half ton per day process development unit. They plan to build a 25 ton per day pilot plant in the immediate future. Present estimates indicate that total development of the Julia Creek tract, including plant design and construction, and pipeline construction, will cost $8 billion. The process appeared to be economically attractive in 1980 based on current oil prices. The plant will produce about 100,000 barrels per day of oil from shale. The deposit has an overburden ratio of 1 foot to 2 feet thickness of the resource. Generally the oil content is 17 gallons per ton of shale. He advised that water supply is adequate for the anticipated plant.

The shale retorting method developed by CSR produces a large amount of liquid, along with a substantial amount of gas. The residual shale is combustible and the carbon is burned to make the project energy self-sufficient. Their refinery plans includes hydrogenation. Mr. Hodgate advised that there are presently no plans for nuclear energy in Australia, that it was rejected for economic reasons in that electric power generation by coal appears to be much cheaper.

Briefing and Tour at Canberra Deep Space Communications Complex

Location: Canberra, Australia.
Date: January 14, 1983.

SUMMARY

The Canberra Tidbinbilla Deep Space Communications Complex is part of NASA's worldwide Deep Space Network which supports the scientific investigations of the planets and interplanetary space. Planetary spacecraft are dependent upon Earth-based equipment for guidance and control, as well as for receiving and processing the vast amounts of information they acquire and send back. The Deep Space Network which performs these functions include the Deep Space Stations based around the world, a central control organization, and the ground communications that link them together. The Deep Space Network is operated for NASA under the system management and technical direction of the Jet Propulsion Laboratory. In addition to the Canberra Tidbinbilla station, other Deep Space Stations are located at Goldstone, California and Madrid, Spain.

DISCUSSION

The delegation was hosted by Joe Kerwin, a NASA astronaut currently serving as NASA Senior Scientific Representative in the United States Embassy in Australia.

The three stations of the Canberra Complex are Weemala (DSS 42), Ballima (DSS 43), and Honeysuckle Creek (DSS 44). The Weemala and Ballima stations are co-joint units; that is, they are located at the same site and share buildings, equipment, and personnel, but have their own antennas. The Honeysuckle creek station, located at a separate site, has its own antenna, buildings, equipment, personnel, and certain support services.

The Canberra Complex was created and operates under bilateral agreements established between the governments of the United States of America and Australia. These agreements were signed by both nations for mutual cooperation in the scientific investigation of outer space (the moon, the planets, interplanetary space). The Canberra Complex is operated for NASA by the Space Project Branch of the Australian Department of Science and the Environment.

The Australian Government has cooperated with NASA in the operation of tracking stations since the late 1950's, when satellites were first put into orbit. A number of stations have been operated for limited periods in various parts of Australia, but, over the years, technical advances and experience have consolidated the tracking and data collection requirements so that the present DSN complex now meets all of the deep space needs of NASA in that part of the world.

The equipment, construction, and operation of the complex are financed by NASA. However, the design and construction of station

buildings and support facilities, as well as management and operation of the stations, are provided from Australian resources, either directly by the Australian Government or by contract to private industry.

Engineering services for the buildings and facilities of the stations are provided or arranged by the Network Support Facility at Fyshwick, Canberra. This unit works closely with its counterpart in the NASA organization and with the appropriate Australian Government Departments.

The Canberra Deep Space Communication Complex began in 1964 with the completion of a 26 meter antenna and associated facilities. This antenna was later enlarged to 34 meters. Following completion of the manned Apollo and Skylab another antenna located at Honeysuckle Creek was modified and completely reequipped in 1974 to join the Deep Space Network. NASA is planning to dismantle the Honeysuckle Creek antenna and move it to Tidbinbilla in order to reduce manpower and costs.

Briefing by Senator Sir John Carrick, Minister of Energy

Location: Canberra, Australia.
Date: January 15, 1983.

SUMMARY

Sir John Carrick briefed the delegation on the current energy situation in Australia. The briefing was followed by a question and answer period which ranged broadly covering synthetic fuels, conversion, uranium markets, oil pricing, and OPEC's future.

DISCUSSION

Sir John Carrick is a member of the Australian Senate and Cabinet Minister for energy; he has held this position in the current government since 1975. In 1981, he was chairman of the International Energy Agency, a rotating post. In his briefing, Mr. Carrick made the following points:

1. Australia is now 67 percent self-sufficient in oil production. Most of the current production comes from the Bass Straits oil fields between the mainland and Tazmania. These are expected to decline in production after 1990. Thus, maintaining oil self-sufficiency will become more critical in the future; they are optimistic that additional oil deposits can be found or other fossil resources can be converted into liquid fuel.

2. Australia has an abundance of coal and natural gas. It has the most abundant coal resources in the free world after the United States. By comparison to U.S. gas resources, Australia's gas deposits are small. However, Australia's annual demand for natural gas is about 1/40th of the U.S. annual consumption of natural gas.

3. Australia has very high grade, inexpensive uranium deposits. It does not expect to use these resources domestically in the next 20 years.

4. The current world-wide recession is affecting Australia's energy export business dramatically, adding to the already difficult situation the country faces in its manufacturing industries and drought stricken agricultural sector.

5. The International Energy Agency's (IEA) assessment is correct that Australia can be an energy exporter in the 1990 to 2000 period equivalent to half of Saudia Arabia's present export level. The nature of the exports, however, will be quite different—coal and uranium instead of petroleum.

In discussing the role of synthetic fuels as a replacement, Carrick noted that the oil shale and brown coal deposits of Australia could be exploited without developing new technology. He commented on the Japanese participation in the brown coal liquefaction pilot plant at Morwell, Victoria. He also suggested that it might be of interest to the

Australians to convert some of their natural gas to gasoline via the Mobil process in imitation of the New Zealand project. He said that the price of gasoline in Australia is the second cheapest in the world about 10 percent above U.S. prices. Thus, the cost of petroleum would have to rise considerably before synthetic fuels would be attractive.

He emphasized the importance of fostering conservation which he called an "economic weapon". He noted that 30 percent of energy demands could be eliminated without touching living standards. Conservation has a particularly important role to play in meeting electricity demands, since conservation is a much cheaper way to satisfy new demands than building costly fossil or nuclear fired power palnts. He felt that this would be particularly the case in the next 10 to 15 years.

In discussing Australia's involvement in exporting uranium, Mr. Carrick affirmed the IEA position that eventually nuclear power will become the energy resource of choice. This would be the case no matter how stringent the conservation activities or how successful investments in renewable energy resources will be. He sees the growing awareness of acid rain as a disqualifying feature for coal fired energy conversion; this will lead to a renaissance in the public's demand for nuclear power. He emphasized the deep concern already in place in Europe and Canada over acid rain. Other than nuclear, there is no large scale technology available for electric power generation that can mitigate the problem of acid rain. Speaking of the issue of American and Australian competition for uranium exports and uranium enrichment, Carrick felt that they are not really competing against each other, but at this time are competing with a world in recession.

In discussing Australia's oil pricing policy, he discussed the government's decision to price Australian crude oil on a par with the OPEC price. This import parity price is an assessment of its replacement costs and is based on the price of Arabian light crude oil landed at the refinery port nearest to the field producing the Australian crude. The import parity price is the price paid by refiners for Australian crude oil and is adjusted every 6 months. In 1982 the parity price for Australian crude has increased primarily because of the movements in the exchange rate between the Australian and U.S. dollar.

In responding to questions on this "reverse" regulated pricing policy, Carrick discussed the importance of supporting Saudi Arabian efforts to maintain the OPEC oil price and the OPEC organization. He is worried less about the economic than the political destabilization in the Middle East if OPEC collapses. He suggested that it would be very important for President Reagan and his administration to listen carefully to the Saudi's concerns in the (e.g. regarding Iran) area and to work with them to maintain a stable world price for petroleum over the next few years.

EMBASSY BRIEFING—JAPAN

Location: U.S. Embassy, Japan.
Date: January 17, 1983.

SUMMARY

The Charge, Mr. William Clark conducted an informal briefing on US/Japanese economic relations, and the political changes as a result of the election of the Prime Minister Yasuhiro Nakasone.

DISCUSSION

Prime Minister Nakasone left the afternoon the delegation arrived for a visit to the U.S. and meetings with President Reagan. After his election we were told that he had called the leaders of ASEAN, China and Korea. Mr. Clark indicated that he is a very direct man with a good command of the English language. Nakasone is interested in increased defense spending. This is illustrated by the percentage increase for defense (6.5 percent) at a time when the remainder of the budget is flat, 30 percent of the budget is in deficit, and internal debt has skyrocketed.

The Japanese government has made some trade jestures by lightening the tariffs on tobacco, chocolate and biscuits. However, the U.S. goal is to broaden its market share, and the Japanese monopoly on the manufacture and distribution of tobacco makes this difficult.

The metal baseball bat case was reviewed, and the delegation learned that after protesting some earlier barriers erected by the Japanese on safety certification, that an arrangement is being finalized which permits safety certification by the U.S.'s United Labs.

The local content bill which passed the House at the end of the last Congress has faced a strong but mixed reaction in Japan. Mr. Flippo felt that changes will continue to be pushed to protect U.S. labor, particularly if reciprocity is not followed.

During a discussion of reprocessing it was pointed out by the embassy briefers that if the Japanese are not allowed to reprocess they will go somewhere else for uranium and the United States would lose its market.

Shifting to agriculture, the delegation was told that the average Japanese eats almost as much wheat as the average American, and that Japan is still the U.S.'s largest exporting customer for wheat. Last year Japan imported $5.7 billion in agricultural commodities from the United States, including 60 percent of the U.S. beef exported, and 40 percent of the citrus.

Turning to economics again, the delegation learned that while debt financing bonds are regularly issued to finance the debt, the central bank did tell the prior government that it didn't want to buy any more bonds.

The Japanese do try to target industries, steel and computers being examples. Its economic planning agency is keyed into the government. Japan has phased out industries such as the coal industry which may be easier in Japan than in the United States since the unions are company unions instead of federal ones. Another factor which facilitates the transition is that there are often times loosely held company conglomerates—which makes it possible to move people within the overall company.

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U.S.-Japanese Diet Meetings

Location: Tokyo, Japan.
Date: January 18, 1983.

SUMMARY

The second meeting of the joint U.S.-Japan Parliamentary Committee was held during the first two days, January 18 and 19 of the study mission's visit to Japan. This committee is an informal group of parliamentarians from the two countries who share an interest, and a responsibility for matters of science and technology in their respective legislatures. The group met for the first time in Washington, D.C. in July 1982. In the day-and-a-half meeting the two delegations exchanged views on technology policy, space cooperation, nuclear waste disposal, and alternative energy sources.

DISCUSSION

Present at the Tokyo meeting here, from the U.S. side, the following Members of Congress: Mr. Don Fuqua, Mr. Manuel Lujan, Mr. Ronnie G. Flippo, Mr. Robert Young, Mr. Dave McCurdy and Mr. Robert S. Walker. In attendance from the Japanese side were: Mr. Jushiro Komiyama, Mr. Ryoichi Nagata, Mr. Fumitake Kishida, Mr. Shozo Kusakawa, Mr. Aaremasa Seki, Mr. Yukihisa Toshida, Mr. Tetsuo Kundo, Mr. Yoshidi Mori, and Mr. Kokai Nakamara all from the Diet House of Reprenstatives; also Mr. Taro Nakayama, Mr. Masao Goto, and Mr. Atsushi Ejima of the Diet House of Councilors.

OPENING REMARKS

Mr. Komiyama opened the joint meeting by welcoming the parliamentarians in attendance. He noted the importance of science and technology in both countries. Recently there have been trade problems between the countries, but they only serve to underline the need for better mutual understanding. The joint meeting is therefore most timely.

Mr. Fuqua noted that the joint meeting serves several important purposes: advancing understanding of approaches to science and technology issues in the two countries; furthering bilateral science cooperation between Japan and the United States; insuring that the current issues of competition in trade and technology do not overshadow longer term cooperation between the United States and Japan which is the interest of both countries. He especially emphasized the last point. We are all aware of the many points of friction between our two countries in the area of trade. They include concerns about: the growth of Japan's exports to the United States which may have contributed to some dislocation in the American economy; the desire by the United States to strengthen its exports to Japan and Japan's

comparable concern about possible dislocations in Japan's economy; the barriers of various kinds which both countries find it difficult to reduce quickly and totally.

Congressman Fuqua was hopeful that, in the long run, we can surmount those difficulties. He said that, with good will on both sides, we can do so, and he believed that it is in our mutual interest to do so. We share a democratic form of government, and we have common defense interests in the Pacific Region. In the longer term, those interests far outweigh the short term trade issues, important as they are.

In America the leadership shown by Prime Minister Nakasone in this field has been noted. We have high hopes that the Prime Minister's visit to Washington this week will be a signifiant step on closer U.S.-Japan affairs. Science cooperation will undoubtedly be a significant factor in those affairs. Both science and technology are characterized by a balance between cooperation and competition, and a comparable balance can be reached in the science and technology relations between Japan and the United States. These parliamentary meetings will contribute to that balance through a free and frank discussion.

Mr. Fuqua expressed his appreciation to his counterpart in the Diet, the Chairman of the Committee on Science and Technology Mr. Komyama, for initiating these important meetings.

Mr. Lujan, as the Ranking Minority Member on the U.S. Delegation said that the meeting in June 1982 in Washington with members of the Diet, was very helpful to him. The exchange of information was both extensive and comprehensive. During this visit he felt that we can continue that kind of discussion. From a look at the full schedule, it is certainly obvious that a great amount of effort has been expended to keep us fully occupied and to provide a wide range of information. The scope of this subjects, which we will consider, is an indication of the wide range of interests which we share between our two countries.

In the fields of science and technology, Lujan expects exciting times in both the immediate and distant future. He believes that the two countries can share in these exciting times. This will call for continuing dialogue and it is hoped that these meetings will help to set the tone and extent of future discussions between our countries.

TECHNOLOGY POLICY

In his opening remarks Mr. Komiyama again stressed the increasing importance of science and technology in both country. The promotion of science and technology is most important in Japan. The Prime Minister in a speech last year confirmed Japan's policy of encouraging science and technology as a national target. Committees on science and technology have been established in both Houses of the Diet. In the longer term the aim is to strengthen basic research, and to place further emphasis on substitute energy development.

Japan's industrial revolution took place in the mid-nineteenth century, but has up until recently relied on imported technology. Today $1.7 billion per year is being paid in patent and license fees to various countries. In the area of technology policy two major thrusts are being pursued: (1) the augmenting of Japan's technology capability.

through the creation of new technologies from the basic stage, and (2) the strengthening of international cooperation where, as the second largest economy in the free world, we have a duty to contribute actively, and where we must especially create new technology for transfer to the developing countries. We hope that we in the Diet and in the Congress can become the leaders of such cooperation.

Mr. Komiyama noted that one vehicle for such cooperation will be Japan's EXPO–85, the exposition which will take place in Tsukuba's Science City outside Tokyo in 1985. While the United States has already signed up to participate, only $4 million has been allocated for the U.S. pavillion and general participation. In comparison with other participants, notably the Soviet Union, this is very modest and the Japanese side urged that the budget for the United States at EXPO–85 be increased 3-or 4-fold. Mr. Komiyama noted that the Japanese Ambassador in Washington had been asked to raise this matter, and that he hoped it would have the support of American legislators in 1985. Japan's legislature has also been asked by the European council to hold a symposium on "Science, Technology and Democracy". This could be a significant event, and the Japanese side asked the U.S. legislators to give thought to possible participation in this symposium.

Chairman Fuqua opened the U.S. discussion of technology policy with some general observations on matters of current concern in the U.S. Congress. DNA research is of special interest and holds promise for making a major contribution to an increase of the world's food supply. Acid rain is a problem of great concern and needs emphasis because of the international effects it produces and the potential for international cooperation in its solution. The future direction of science policy in the United States is a matter of interest at this point in time and may well be reviewed in some detail. Finally, science education is an issue which will continue to be of concern because more students are needed in the fields of science and engineering.

U.S. participation in EXPO–85 is understood to include the possible participation of the shuttle vehicle "Enterprise", and the cost of this may not be included in the $4 million figure. In any event, the United States will want any appropriate exhibit at EXPO–85, and the U.S. delegation will put this matter on its agenda.

An overview of more specific issues in the field of technology policy was presented on behalf of the U.S. side by Mr. Walker. This is a very large subject, Mr. Walker noted and he said he would focus on a few aspects of particular interest to us in the United States at this time. To us and, he thought, to policy-makers in Japan, the distinction between "sunset" industries and "sunrise" industries is very real, although it must be used with some care.

The United States is now faced with questions about what role government should play in dealing with these two categories of industry. We are interested in learning how Japan has approached these questions. For the emerging sunrise industries, most of them in the high technology sector, we are reviewing the following kinds of issues: Tax policy. To what extent should we give further incentives for research and development to insure continued vitality? Small Business: We recognize that a disproportionate number of innovations are made by small R&D firms. Last year the Congress enacted legislation directing

that Government agencies supporting R&D must grant 1.5 percent of those funds to small R&D firms. It remains to be seen how effective this approach is or whether other approaches must be pursued. Anti-trust policy: Current law and practice prevents firms in the United States from cooperating in R&D activities of common interest. Can we relax those restrictions without endangering competition which the anti-trust laws were designed to preserve? Ethical issues: Noting that his own Congressional district in Pennsylvania is located next to the Three Mile Island Nuclear Power Plant, Mr. Walker observed that many new technologies with the potential to produce harmful effects must be evaluated and introduced with such potentials in mind.

For the sunset industries, many of them in the basic industries sector, other policy issues are facing us. Again, we are interested in exchanging views with our Japanese colleagues about the practices and experiences in Japan and America. Which industries must be maintained at an unreducible level to serve national security requirements in the event nondomestic sources are cut off? When must the reduction in the number of companies in an industry be accepted to match market demand, and what role, if any, should Government play in that kind of decision? The inevitable unemployment faced in many sunset industries raises questions of retraining. Can Government play a role here, directly through retraining or indirectly through financial incentives to individuals or firms?

We all recognize that declines of individual industries is due to different causes: Declines may be due to the world recession, as for example in shipbuilding. Declines may be due to growing energy costs in an energy intensive industry, as for example aluminum. Declines may be due to increased competition from developing countries, as for example in textiles. Declines may be due to increased competition from developed countries, such as for example the construction equipment industry. In each case Government policy must take these differing causes into account in formulating an appropriate response.

The current recission will end. It may be some time before full economic growth is attained. But when it does Government policies, including technology policy, must be ready to respond. We look forward to discussing those policies with our Japanese colleagues during this meeting.

TECHNOLOGY POLICY DISCUSSION

In the ensuing discussion the following points were made. Since the Meijii restoration Japan has expanded its educational system. The educational system is influenced by Confusianism and Buddism. The underlying philosophy is that no progress will be made in society without adequate education. After the war, the Japanese system of education was totally changed. Most members of today's older generation studied with a tutor at home, while the younger generation attends public schools.

In Japan about 10 years ago, a law was passed to ensure adequate pay for teachers. Prior to that time, many teachers had been moonlighting to make ends meet. The law gave teachers a pay level 20 percent higher than other Government employees. For example, a science teacher now makes the same as a deputy director of a Government agency. A surviving spouse will get 80 percent of a teachers pay.

Japan is now facing a slight excess of teachers. It must be noted that higher salaries are not just for science and mathematics teachers, but also for nurses and certain others.

Corporate contributions to education is almost nonexistent. Companies do contact students at an early stage, and entrance examination must be passed in order to be hired. In a few cases large companies take in young people and give them a high school education.

Career choices in Japan between a technical career and non-technical career is made at the 11th grade. In analyzing further choices we must recognize that they are often made based on newspaper stories. The 10th grader gets the very basic things—all students need this.

An important issue in Japan is how to instill creativity. It is very difficult to do. The person must have a certain amount of knowledge. Japan is very concerned about stimulating creativity.

The central Government funds education nation-wide, and therefore controls the curriculum. Of the total budgets for elementary and secondary schools, half comes from the national Government, 30 percent the prefectures, and the rest by each locality. There are national curriculum standards. For the last 100 years that has been the case, and as a result Japanese schools accept such uniform programs and standards.

REMARKS BY TAKAAKI YASUTA, DIRECTOR GENERAL, SCIENCE AND TECHNOLOGY AGENCY

At the afternoon session, the Director General of Japan's Science and Technology Agency, Mr. Yasuta gave a short opening speech. Needless to say, the world today has increased its use of science and technology and its reliance on these factors. Especially since the onset of recession throughout the world, the use of science and technology has been sought as a significant source of economic adjustment. After the summit conference last year at Versailles, a working group to look into this question was established.

In United States-Japan bilateral relations, the initial science cooperation agreement was signed when Mr. Ikeda was Japan's Prime Minister and Mr. Kennedy was America's President. Since then cooperation has been successful in many fields. Japan will be holding EXPO–85, and we sincerely want full scale participation in that event. We also hope to meet with U.S. legislators in connection with the exposition.

PRE-COLLEGE SCIENCE EDUCATION

On behalf of the Japanese side, Mr. Kokai Nakamura presented an overview of science education in Japan. Current science education at the pre-college level is based on the law for science and mathematics education which was enacted in 1953. This law established a uniform program of science and mathematics education throughout Japanese schools, and provided for the training and retraining of teachers. In fiscal year 1983, 2.5 billion yen were earmarked for facilities and equipment to be used in science and mathematics education, and for centers for on-the-job training instructors.

Students in the ninth grade now take 4 hours of work in science and 3 hours of mathematics. In high schools, students take the same study load plus electives. Japanese high schools have a drop-out rate

of only one percent. Teachers have 2 years or more of science training. In a recent survey of high school science education in 20 countries Japan ranked the highest.

In 1961, another law was enacted on industrial education. Public support in this area amounts to one-third of total costs. In addition, private firms conduct extensive programs of science and mathematics education.

Information processing is now widely taught, and computers are being introduced into the classroom rapidly. Four thousand computers have been placed in high schools to date, and instructors are also being trained. Japan supports similar activities in other Asian countries.

For the U.S. side, a discussion of science education was conducted by Mr. McCurdy. In 1957 the Soviet Sputnik sent the United States into action to upgrade its science education. Today the United States is facing a comparable situation and it is not too far fetched to suggest that it would be better understood if a Toyota automobile was launched into orbit.

The problems in science education which the United States is facing can perhaps best be summed up through the following questions. (1) Are career decisions guided by the choice of training in the universities or by market demands? (2) in both countries who sets curriculum? In the United States, given the role of local Government, should the Federal Government play a stronger role? How are curriculum decisions made in Japan? (3) At what point are students required to make a career choice? (4) In the United States there is a shortage of science teachers. Senator Glenn and Congressman McCurdy proposed legislation to establish incentives for a career in science teaching. What incentives are there in Japan for students to enter science teaching as a career? What are the minimum levels for science teaching?, and (5) What is the role of business in local curriculum development? To What extent do firms work with local teachers? Do businesses get any tax credits for such activities?

NUCLEAR WASTE SESSION

The S&T delegation met with Diet members to discuss nuclear waste and related issues in the nuclear power area.

Mr. Lujan presented highlights of the Nuclear Waste Policy Act of 1982 in his statement, which follows:

Nuclear waste disposal

Last year, during your visit with us in the United States, we held a technical session on the nuclear waste question. At this time, I would like to give you an update on the activity since that time to the present time.

One of the final accomplishments of the recent 97th Congress was the enactment of a high-level nuclear waste disposal program for our Nation. As you may know, Congress has been debating nuclear waste disposal issue for many years. Finally, the great effort made to bring together the various concerns of the many groups who have an interest in waste disposal has been successful. I am glad to report that President Reagan has signed this bill into law.

By now, our Nation has accumulated nuclear waste from operation of facilities over the past 40 years. A growing concern among the pub-

lic was the storage and disposal of this material. An equitable solution to the problem of nuclear waste, therefore, was necessary to lessen opposition by some of the public to the increased use of nuclear power.

The passage of this legislation has occurred so recently that it may be well, at this time, to review briefly the provisions of the act:

(1) A permanent burial site is to be selected by mid-1987 and to be operated by the late 1990's. The site selection process starts with nominations and characterization of five potential sites in at least three different types of geological formations.

(2) The States are given the right to object to a site; their veto can only be overturned by a vote of both Houses of Congress.

(3) There are provisions to make it easier for utilities to expand their storage capacity at the reactor sites, as well as authority for the Government to provide last resort storage at existing Federal facilities.

(4) A design study is to be done for a third kind of facility for long term storage of up to 100 years. This third type is termed "monitored retrievable storage."

(5) A test and evaluation facility is to be built at the discretion of the Secretary of the U.S. Department of Energy. Incidentally, our committee initiated the test and evaluation facility concept and strongly supported it through all the discussions in the legislative process.

(6) A requirement that all facilities be paid for by utilities through a surcharge on electricity generated by nuclear reactors.

(7) The President is to determine whether military waste should be exempted from the requirements in the Bill, although if there are separate military waste facilities they will be subject to the same State veto procedure.

This legislation is very significant. For the first time, the United States nuclear fuel cycle has been recognized in its entirety, from extraction of uranium ore to the disposal of waste materials. I have provided you a very short outline of the legislation and would be glad to discuss any of these provisions in greater detail. Thank you for this opportunity to share our successes with you.

Mr. Lujan briefly outlined the timetable for construction of the T&E Facility and the first repository.

Short description of the timetable for Construction of the T&E facility and the First Repository for Nuclear Waste

The overall schedule for a nuclear waste repository in the near term must focus on research and development activity through a Testing and Evaluation (T&E) facility. The Department of Energy will have to recommend three sites in at least two different media for such a T&E facility within one year after the passage of the Act, that is, by the beginning of 1984. Within 3½ years, the DOE has to select a site for a T&E facility and no later than just over 5 years after the passage of the legislation, the DOE is to go ahead with mining and construction of such an R&D facility.

This schedule parallels the schedule of the overall repository and the R&D facility can be colocated at a candidate repository site or sited separately. In the case of the colocated facility the actual mining

and construction is delayed until after the President makes a decision on the site for the permanent repository. The repository schedule is as follows: within 6 months the DOE must nominate 5 sites, and within 3 years, roughly beginning in 1985, 3 sites must be recommended for characterization by the DOE. Within 6 months after that, the President must make a decision on these sites for characterization. Thus, he must make a decision to characterize these sites within 3 years from now and within 4 years, by the early part of 1987, the President must make a recommendation for construction authorization of the repository unless he requests a 1-year delay. The construction permit for the repository is requested from the NRC by the DOE and by January 1, 1989, 6 years from now, the NRC must make a decision. Such construction authorization could be extended by 1 year. Thus, it is conceivable that, given 8–10 years to construct the repository, it could be in operation sometime between the year 1997 and the year 2000.

Mr. Kusakawa summarized status of Japanese low-level and high-level waste programs. They are doing assessments and site surveys assuming they will glassify waste from reprocessing.

Mr. Kusakawa asked eight questions concerning the problem of scrapping nuclear powerplant reactors.

Nearly 30 years have passed since construction of nuclear powerplants started and reactors of the plants are approaching their limit of durability. My questions concern how large light water reactors which are no longer safe to use should be dismantled and scrapped. Specifically, I would like to know about the prospects of dismantling technology, removal of pollutants, and estimation of the cost, and the state-of-the-arts in the United States. In Japan, the cost of reactor dismantling is said to account for several to 20 percent of the cost of construction (which is estimated at 250 billion yen ($1.08 billion) per 1,000 Mw unit)—which means approximately 50 billion yen ($217 million) will be required to dismantle the reactor when 20 percent of the cost of construction is required for dismantling. My question is how the required cost of dismantling should be added to the power rates.

Questions concerning reprocessing negotiations.

The working-level consultations on the question of reprocessing of spent nuclear fuel have become prolonged. Why cannot a basic agreement lead to a final agreement? Moreover, (1) In 1978 the Nuclear Nonproliferation Act was enacted in the United States. I hear that Democrats take the position of strengthening this legislation. What is your opinion? I also hear that even among Republicans there are those strongly in favor of nuclear nonproliferation. What are the Republicans' view? (2) I hear that nuclear powerplant construction plans have been suspended successively. Why? It is said that factors include a rise in the cost of construction, the difficulty of raising funds, a slow-down of the demand for power and stringent regulation by the Administration. What is your view? (3) What are the future prospects of the Clinch River Project on FBR (I hear that the Project is in abeyance) and how Japan and the United States should cooperate technically for the development of the FBR. (4) What is the U.S. policy for cooperation toward developing nations and technology transfer? (5) What is the U.S. view on the inactivity of the nuclear development program in the United States and what can the Administration do in overcoming this situation?

S&T Responses to Nuclear Questions

The following are responses which Mr. Lujan made for the delegation to the questions and comments of Mr. Shozo Kusakawa of the Komemito party.

1. The first question refers to how nuclear light water plants should be dismantled.

Response.—Aside from the unique example of TMI, a thermal light water plant will probably be dismantled after its useful life has exceeded roughly 35 or even as much as 40 years. Presently, the Committee is authorizing design studies for the decommissioning of the Department of Energy/Duquesne Power and Light Shippingport reactor in western Pennsylvania. The reactor has been defueled and the fuel is being removed for examination and further research tests pursuant to the Light Water Breeder Reactor program. Aside from this unique aspect of the defueling, the Committee expects the Shippingport experience to be a model for dismantling and decommissioning.

2. The second dismantling question refers to costs. In Japan, Mr. Kusakawa says the cost of the reactor dismantling, and presumably decommissioning, is estimated to range from 7 to 22 percent of the costs of construction of a nuclear power plant where a representative plant would cost one billion dollars for a 1,000 megawatt unit.

Response.—This would amount to several hundred million dollars, which does not sound too unreasonable for decommissioning. The point is that dismantling and decommissioning costs should not be compared to the cost of construction. They really should be compared to the total cost of electricity to the rate payers over the lifetime of the plant. Thus for a 30–40 year plant, such a decommissioning cost should amount to no more than a few mils per kilowatt hour at the most. The analysis of data from the dismantling and decommissioning should provide U.S. industry with an enhanced basis for keeping costs down in future decommissioning activities. However, it does not appear that this will be a major factor in determining electricity rates in the United States. Added to the 5 cents per kilowatt hour national average, the total cost of decommissioning will run on the order of just several percent of the cost of electricity, and could be rolled in prospectively during operation or at the beginning of decommissioning.

Reprocessing

The next set of questions is on reprocessing and there are 5 separate questions in this area. There is a general question as to why there cannot be a basic agreement leading to a final agreement between the United States and Japan on prior consent to have U.S. supplied fuel reprocessed. The major reason why a long term agreement cannot be reached is the lack of understanding of the civilian/weapons linkage in the United States, including elements of the Congress, which results in a lack of consensus on what constitutes a sensitive civilian nuclear technology. In the case of Japan, for U.S.-supplied spent fuel being reprocessed by the French and the British, we are hopeful such an agreement could be worked out, since it does not appear to involve the transfer of sensitive nuclear technology without safeguards. In the case of the United States consenting to additional Japanese facilities, such as a nuclear fuel fabrication pilot plant, we would expect that the Japanese would agree to safeguards consistent with reasonable U.S. non-proliferation policy.

Responses

1. Regarding the Nuclear Non-Proliferation Act (NNPA), all Democrats and Republicans should be interested in strengthening nuclear nonproliferation. However, it is a fact that the NNPA of 1978 has been the object of significant controversy under both the Carter and Reagan Administrations. The Act could be strengthened by more focus on sensitive nuclear technology, such as enrichment and reprocessing, but we would hope that the Act would not be modified so as to encourage unilateral U.S. cutoff of relatively nonsensitive nuclear technology and material under cases where receiver nations would agree to proper safeguards.

As on other nuclear issues, it is not clear that there is a separate Democratic or Republican view in the Congress. Both parties would be significantly divided on how to approach modification of the Nuclear Non-Proliferation Act.

2. The fact is that for nuclear power plants, the construction plans have been altered such that no new orders have been forthcoming and a significant number of plant cancellations have taken place over the past several years, mainly for the reasons mentioned by Mr. Kuzakawa (i.e., a great increase in construction costs because of the time it requires to construct the plants, and the high interest rates leading to a very high cost of money.) This makes it difficult to raise capital and the rating of utility bonds has been dropping. Also, there has been a significant reduction in the growth of electric power demand, not only from the ambitious and optimistic levels projected in the early 70s, but even from more modest growth levels, chiefly because there is a serious economic recession. Thus, this is a very difficult time to forecast electric power demand. It should be noted, however, that the U.S. quality of life has benefited greatly from the use of electricity, and there is still a strong correlation between the growth rate of electricity and the increase in real GNP. The strict regulation of nuclear power has been the case under several recent administrations, and the TMI accident has aggravated such concerns, but the positive effect of TMI has been the commitment of electric utilities and the nuclear industry to police themselves and insist on better quality assurance in power plant operation and construction. We, on the Committee, believe this positive trend will continue, and have encouraged the NRC to focus on real safety issues.

3. The Clinch River Project's prospects is the question. Prospects for CRBR are still uncertain because of recent votes in the Congress. The Department of Energy is going ahead with extensive site preparations, but no actual plant construction would begin for several months, while recent appropriations legislation stipulated that no nuclear reactor construction can begin in fiscal year 1983. So, in a sense, the project is not going forward at the pace it could, but $181 million is available through fiscal year 1983. The Japanese and the United States should be able to cooperate by doing what each other does best under existing technical agreements. For example, the United States has very advanced component designs on items such as steam generators and a strong fuels program; presumably exchange of data on testing equipment and advanced fuels could be done in return for obtaining data from Japanese operating experience on MONJU, etc.

4. The fourth question is on U.S./developing nations technology transfer. If this question is directed specifically to nuclear aspects of U.S. policy, then such policy toward developing nations should be the same as toward developed nations, except that we would not encourage developing nations to embark on ambitious nuclear power plant programs. For instance, programs across the entire fuel cycle don't appear appropriate, since such services could be bought from other "reliable supplier" nations and such resource requirements would generally be beyond the capability of developing nations. Overall, U.S. technology transfer should be the same as was mentioned under the questions about nuclear nonproliferation, that is, to focus on transfer of sensitive nuclear technology only, and to require nuclear technology and materials be generally made available under reasonable safeguards.

5. The fifth question is on the U.S. view of what could be done to improve the nuclear development program by the Administration.

The Administration could help in overcoming the gap between real risk and the public perception of risks of nuclear power by going forward with an objective but aggressive nuclear public information program. This would reduce the effects of the extreme views articulated by certain anti-nuclear groups. However, the administration has put the nuclear advocates in Congress at a disadvantage by cutting deeply into non-nuclear R&D programs to the extent that the nuclear program, including the breeder reactor program, have become funding targets for many Members of Congress who have seen their own programs reduced or terminated. These people cannot understand how the United States can sustain a relatively well-funded nuclear program under these conditions.

Mr. Lujan responded for United States on all points with a personal perspective on Clinch River project.

The U.S. group addressed the CRBR and fast breeder technology program and called for increased cooperation, recognizing that French and Japanese have greater urgency to commercialize the breeder. (In view of U.S. uranium resources, lowered electrical demand, etc.) Mr. Kondo called for United States, Japan, France trilateral FBR commercialization program. Obstacles to licensing French breeder technology (Mr. Walker) and proliferation concerns about French nuclear policy (Mr. McCurdy) were raised. (Committee's study of FBR program alternatives, e.g., testing U.S. components in foreign breeder plants, was not mentioned. United Kingdom and French were not interested in such U.S. proposals because they require plant shutdowns of 1½ to 2 years.)

The bipartisan nature of Congressional split on nuclear issues was mentioned.

Japanese emphasized their critical need to have U.S.-supplied fuel reprocessed for LWR's and breeders and requested support from S&T delegation on this matter. S&T Members expressed empathy for Japanese plutonium needs but told Japanese that there is considerable sentiment in the Congress for strengthening the Nuclear Non-Proliferation Act (NNPA). Mr. Lujan noted significant U.S. advances in nuclear safeguards technology.

Mr. Kondo asked about HTGR and Mr. Fuqua pointed out that the Committee had carried the program in the face of opposition by

two Administrations. He noted that S&T still considers program worthwhile and agreed that cooperation with Japan and FRG makes sense.

There was considerable discussion of fusion and fission cooperation and general agreement on need to cooperate because of limited resources to pursue capital intensive projects. (There was no distinction made here between fusion agreements where the program is in the research phase and chiefly basic data is being shared, and breeder technology agreements where commercial licensing issues are critical. For example, the U.K. has not reached an FBR agreement with the French after 3 years because the French want "an arm and a leg".)

Mr. Flippo noted that the Fast Breeder Technology Program will be attacked if CRBR is terminated and Mr. Lujan warned that magnetic fusion will draw strong opposition when it reaches the demonstration reactor stage.

Discussion closed with brief discourse on DOE's survival, noting that its regulatory functions have been chiefly eliminated.

ALTERNATIVE ENERGY SOURCES

A member of the Diet outlined the Japanese efforts in research and development on alternative energy resources including nuclear, ocean energy, wind energy, and biomass. The United States delegation outlined similar programs and included discussion of the Synthetic Fuels Corporation.

Since Japan imports 99.8% of its petroleum, the need to develop alternative energy resources is great. In addition to its own large use of energy, Japan sees other incentives for trade due to the global demand for oil substitutes.

There are major efforts under way in the development of nuclear fission option. They expect nuclear to replace some 20% of their total oil use by the year 2000. They will rely on the light water reactor, the safety of which they consider proven. They are pursuing research on fast breeder reactors, but feel that closing the nuclear fuel cycle through reprocessing and waste disposal are of preeminent concern. They are also involved in nuclear fusion R&D through cooperative international programs.

In fossil fuel they have developed coal liquefaction methods for both brown coal and bituminous coal. The brown coal activity is in cooperation with Australia where they have constructed a 50 ton per day pilot plant outside the Melbourne, Australia. At the current time, they are investigating three methods at a 3-4 ton per day scale. They will combine the results of this research into a single process to be developed at a 100–200 ton per day pilot plant scale, similar to the Exxon Donor Solvent and H-Coal pilot plants. They are also pursuing coal gasification, coal-oil mixtures and fluidized bed combustion. In the renewables area, they mentioned the joint projects, pursued under the IEA agreements, in geothermal and hot dry rock. They see geothermal as a way to replace some 200 megawatts of electric power capacity. In particular in Kyushu, they see wide utilization of their hot dry rock resources.

The development of photovoltaics depends on the reduction of the price of solar cells; although further cost reduction is expected, addi-

tional R&D is required. The path which the Japanese are pursuing with the most interest is the development of amorphous silicon devices. They also expressed interest in large scale solar thermal generation of electricity using power towers and have tested a 1 MW power tower.

Japan has established a Marine Science and Technology Center to study production of energy from waves and ocean thermal gradients. This center received 100% government funding from 1976 to 1980. Research on waves continues to be under study; in the OTEC area they are developing high performance heat exchangers. There has been much utilization of small scale wind energy turbines; they are now developing large scale wind projects which they expect to be implemented within the next 5 to 10 years. In biomass, basic studies are being pursued.

The delegation expressed continuing commitment to the development of fossil and renewable energy resources. The recent budget reductions in the Department of Energy's R&D programs in these areas were discussed. The commitment of Congress was emphasized in retaining a reasonable level of investment in these areas but with a restructured program emphasizing core basic research and maintenance of technical expertise and manpower. They saw this restructuring of the programs as an opportunity for continued and improved cooperation with the Japanese in technologies of mutual interest.

The discussion between the Diet members and the delegation covered several topics: The SRC I and SCR II coal liquefaction projects, the use of hydrogen for transportation, the need for an aggressive commitment to nuclear power, the future of OPEC and the need for an international survey of the biological resources of the world.

In July of 1980, Japan signed an agreement with the United States and the Federal Republic of Germany to provide one quarter funding of the SCR II Coal Liquefaction Demonstration Plant. This direct liquefaction technology was developed by Gulf Oil Company with support from the U.S. Department of Energy. Original cost estimates for the demonstration plant were in the vicinity of $1.2 billion. When President Reagan reconsidered the budget for Fiscal Year 1981, he requested rescission of funds for the SCR II project and initiated termination. This was viewed with displeasure in Japan at the time. In the discussion, the Diet members expressed a continuing concern with this event and were curious as to the Committee's position on SCR II and the current status of the SCR I project. The point was made that this Administration's philosophy emphasizes greater private participation in such large scale projects than was part of the SCR II project. Another point was made that the cost estimates began to increase rapidly shortly after President Reagan took office and the recommendations of the Administration after consultation with governments of the FRG and Japan were accepted by the Committee. In the case of SCR I, the question revolved around the continuing investigations of the solids separation systems being used, which are continuing at the Wilsonville, Alabama, pilot plant.

A strong statement was made that there was not unanimous agreement with the President's decision to insist on private sector responsibility for all activities beyond basic research. Though commercialization was certainly the province of the private sector, there was a

strong feeling among some that research, development and demonstration activities would not be carried out by industry, especially in a time of recession and even in more prosperous times, since the rate of return for such development and demonstration activities is considerably lower than that of other investments.

Another topic was the health of OPEC and the probability of price changes in the near future. The Japanese perception of the current softness in the price of oil is that it is temporary. The price stability of the last few years has arisen because of energy conservation and an inherent reduction in energy demand; however, more important has been the demand reduction induced by the current deep recession. The lessons of the 1973 embargo and the Iran-Iraq war should not be forgotten; however, the current softness in the price of oil also should tell us that we should not be forced into hasty action if and when another shortage occurs. The point was made that the longer we wait to develop alternative energy resources the more they will cost. This is partly the result of inflation and partly because they see the price of oil rising after a respite of five to ten years. They see a new age for energy development and industrial development coming from the use of new resources. The 1980's will be a time of instability; the 1990's must be the time when new technologies are developed to the point of utilization; and after the year 2000, these new technologies must be implemented.

For Japan, nuclear technologies play a critical role. In fact, without the price increases resulting from the oil shortages of the last 10 years, nuclear technology would not be advantageous in Japan as it currently is. However, the oil crisis has also slowed the growth of the world economy, primarily through inflation. This has diminished demand for electricity so that we often hear that nuclear power is not required.

Thus, the oil crisis has produced two rather conflicting consequences. Other topics touched briefly on Japan's research on hydrogen for transportation and the development of ceramics and electric cars. In all cases, Japan was doing small amounts of research primarily in materials for storage and for high temperature resistance.

The Liberal Democratic party, the ruling party in the Diet, organized a study group for the promotion of bio-science and life science. It made recommendations last December on the prospects for the use of recombinant DNA in broad industrial areas and the use of biomass for energy. The statement and recommendations noted that it had been 4 billion years since life began on the earth and it is now necessary to establish a policy to foster and use the biological resources of the world. In attempting to examine the work pursued by the Japanese Government and Japanese industry in these areas, they found it necessary to do a cross cutting survey of various government activities. However, they believe that this is a problem of international significance and that all nations should undertake such a survey. They requested the Committee's assistance in supporting such an international survey and a commitment to treat the living resources of the world as a common resource for our children and their children.

CONCLUDING REMARKS

In concluding the joint meeting the Japanese side noted that all participants had learned a great deal from their colleagues. While there is competition between the two countries, cooperation is, in the long run more important, Mr. Komiyama observed. Science and technology is now entering a very important time. This dialogue will set the tone for future relations, and cooperation in science and technology between Japan and the United States will contribute to a friendly tone.

On behalf of the U.S. side, Mr. Lujan summed up the conclusions of the delegation. The U.S. delegation welcomed this opportunity to continue discussions which originated back in June 1982. We have all participated and he felt our contributions have been meaningful. In these brief sessions we have solved no problems, but we have shared our problems and each person has listened to the other person. That has been important.

We come from a wide variety of backgrounds and experiences. We have a broad range of needs, goals, priorities, and resources, both as individuals and as countries. However, we do have several things in common: The desire for peace, the hope for an improved future, the belief in the worth of man. Now those standards may appear to be nebulous and too vague for attainment. But as we review our agenda, we see those ideals in the very important concepts.

We discussed education, and that is the foundation of man's advancement. We also considered the judicious storage and disposal of a waste material from an important energy source, and that energy offers enhanced living standards. We talked of our space activities, which are really programs important for the expansion of man's mind and universe.

Another topic, technology policy, calls for the rational exploration of our future and the necessary application of our capabilities. An examination of alternate energy sources can be described as an investigation of and improvement in our stewardship of the world's riches. So, all these discussion items related back to those seemingly far-out standards.

Our scientific future looks exciting. We have all supported that forecast as we have spent these hours considering programs which will advance our health, welfare, and prosperity. We certainly share these aspirations and sincerely wish them for others in this world.

Our talks have totally fulfilled our expectations. As is the case with any other far-ranging and complex issues, we were not able to arrive at firm conclusions in such a short period of time. But we are pleased with our ability to jointly explore these subjects so frankly and energetically. Hopefully, we will all part company with the same good feeling of accomplishment which I have.

Chairman Fuqua endorsed these remarks and added that he wanted to express to the Japanese side, as the host for the meeting, his appreciation for the cooperation extended in developing the meeting agenda, for the use of the Diet Chairman's residence and its excellent conference facilities, and for the hospitality extended to all members of the U.S. delegation. He expressed the desire of the U.S. side to join with their Japanesee colleagues in future meetings at a mutually agreed upon time. The meeting was then concluded.

Meeting With Hiddo Watanabe, Parliamentary Vice Minister of International Trade and Industry (MITI)

Location: Tokyo, Japan.
Date: January 18, 1983.

SUMMARY

Mr. Watanabe, who is also a member of the House of Representatives, expressed great pleasure in meeting with the delegation. He gave emphasis to Expo 1985. He expressed interest in the sessions which the delegation had with the members of the Diet and advised that the members from the Diet have important positions. Mr. Watanabe provided extended remarks on the Local Content Bill which was passed by a U.S. House of Representatives action during the past session.

DISCUSSION

Mr. Watanabe was very cordial in the meeting with the delegation. He pointed out that there are problems between the United States and Japan which require mutual understanding and that this kind of discussion should be very helpful in alleviating those problems. He pointed out that the sessions which the delegation had just concluded with the members of the Diet were very important, both as to content and to the powerful positions of the Diet members.

Mr. Watanabe was asked to provide his views of the bill passed by the U.S. House of Representatives during the recent session on the local content of manufactured items in the United States. He went to some length to advise that each country should try to utilize the strengths of each country. He believed that discussion and subsequent action might be much more desirable to resolve problems than through legislation. He suggested conferences. He said that the Japanese point of view is that they have no natural resources and must rely on technology. There must be no limit to import and export and that there must be an expansion of both import and export for the health of both countries. He strongly encouraged continuous consultation. He pointed out that the on-going meetings between the President of the United States and the Japanese Prime Minister should be very helpful in enabling each country to understand the position of the other.

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Plant Tour and Briefing at the Fuji Complex of Fanuc Ltd.

Location: Yamanashi Prefecture, Japan.
Date: January 19, 1983.

SUMMARY

Fanuc Ltd. is a worldwide producer of numerically controlled machines and industrial robots used in a variety of industrial processes. The Fuji Complex, located at the foot of Mt. Fuji, west of Tokyo, consists of the Motor Manufacturing Division, the Mechatronics Manufacturing Division, producing robots and computer controlled cutting machines, and the Technical Training Center.

DISCUSSION

Dr. Eng Seiueman Inaba, president of Fanuc Ltd. welcomed Members and staff of the Committee and presented an overview of the company. This was followed by a tour of the automated motor assembly line.

Fanuc Ltd. is a pioneer in the development of numerically controlled machines, robots and wire cut EDM systems. Since 1972, when Fujitsu Fanuc Ltd. was founded and became independent from Fujitsu Ltd., operating revenue has grown from $28 million to $375 million in 1981. In the same time period, income has grown from $7 million to $130 million; but the number of employees has grown from 620 to only 960.

Fanuc Ltd. produces a range of CNC systems. These include the worlds first three dimensional tracer control incorporating a computer for milling machines and diesinking machines and a highly advanced software-variable function CNC that simultaneously performs up to 15-axis contouring control. Control motors are produced in 40 varieties on an automated line at the Fuji Complex. Available are DC Servo motors with transistor drive, high performance AC Servo motors, AC Spindle motors and AC Spindle Head motors.

Industrial robots are an integral component of the machining and assembly cells that form the basic units of factory production. Fanuc produces robots that perform various machining and assembly operations, and for special purposes such as spray painting and welding. A series of sensors are available to enhance these robots features including an arc welding sensor, a distance sensor and a visual sensor.

The Fanuc Tape Cut series are wire cut electrical discharge machines featuring high speed and accurate machining. Model K is designed to be economical, Model L is capable of taper cutting and is most suitable for medium-sized workpieces, Model M is intended for large-sized workpieces and Model N has a large stroke of 800 mm x 400 mm.

Fanuc also designs Factory Assembly systems composed of combinations of the above elements. Machining cells combine CNC ma-

chine tools with robots or pallet changers and a monitor. Assembly cells consist of assembly robots and peripheral equipment. In FA systems of larger scale, unmanned carriers are used to transport work pieces between cells. An automated warehouse is incorporated for storing work pieces and a host computer is connected to conduct production control.

At the Motor Manufacturing Division, approximately 60 employees using 101 robots produce 40 different kinds of control motors at a rate of 10,000 units per month. Prior to opening of this line in March 1982, 32 robots and 108 operators produced about 6,000 motors per month. The first floor of the motor manufacturing plant is dedicated to parts machining; the second floor, to assembly.

The first floor contains 60 machining cells with 52 robots. Machining is carried out for some 900 varieties of motor parts, in lots ranging from 20 to 1,000 units. Parts machined on the first floor are temporarily stored in the automatic warehouse; they are retrieved when needed on the assembly floor.

On the second floor, the assembly cells, each incorporating one or more robots, are arranged in linear configurations. The cell robot picks up the parts from the pallet left by the unmanned carrier, and assembly is performed. When the assembly work allocated to a given cell is completed, the finished parts are placed on a workpiece feeder and sent to the next assembly cell. In all, there are four assembly lines, containing 25 assembly cells with 40 robots. This factory employs a special scheduling method whereby production is automatically carried out in accordance with pre-planned manufacturing processes.

In the Mechatronics Manufacturing Division, a permanent staff of approximately 100 produces 300 robots, 100 wire-cut EDMs and 100 mini-CNC machine tools each month. Materials delivered to the factory are first stored in a special warehouse. When needed, they are removed from the warehouse and transported to the machining cells using three unmanned carriers. Machining is performed, and the completed workpieces are sent for temporary storage in the parts warehouse.

The system whereby workpieces are supplied by carrier in response to machining cell demand is known as the "demand-pull" method. The factory incorporates a FANUC FA system which permits some 450 different types of parts machining, in lots ranging from 5 to 20 units.

The FANUC Technical Training Center offers information for users to operate its products most efficiently. Technical Training begins with general information on products, with advanced courses for operation and maintenance.

Visit to the Shinkansen General Control Room

Location: Tokyo, Japan.
Date: January 19, 1983.

SUMMARY

The Shinkansen (Bullet Train) is a high speed rail line that connects the major industrial and commercial centers of Japan. The main line extends between Tokyo and Hakata at the northern end of Kyushu Island, a distance of over 1000 km. Travel time is as little as 6 hours and 40 minutes at speeds up to 210 km/hr. The line carries 350,000 people per day, generating 2.2 billion yen, 33% of all Japanese National Railway passenger revenue. The line is one of only two profitable passenger trains in Japan.

The Control Center for the Tokyo-Hakata line, located at the north end of Tokyo Station, remotely controls all aspects of Shinkansen operation. About 70 dispatchers are normally on duty, day and night, working in eight groups. They control passenger information, rolling stock operation, power supply, signalling, communications, maintenance and traffic control of up to 70 trains at any given time.

DISCUSSION

The Tokaido Shinkansen began service between Tokyo and Shin Osaka on October 1, 1964. Its westward extension, the Sanyo Shinkansen, was opened to Okayama on March 15, 1972, and to Hakata on March 10, 1975. High-speed through trains travel the 1,069 km between Tokyo and Hakata in less than seven hours, knitting together the principal industrial and economic centers of the nation.

In their first 17 years, Shinkansen trains have carried over 1,700 million passengers without a single casualty. The 657 million train-km corresponds to nearly 856 round trips between the earth and moon.

Construction plans for three more Shinkansen lines were approved. Two of these lines, the Tohoku (Tokyo-Morioka) and Joetsu (Omiya-Niigata), are completed. The Tohoku Shinkansen opened between Omiya and Morioka on June 23, 1982, and the Joetsu between Omiya and Niigata in November of the same year. Construction is in progress between Tokyo and Omiya and on the third, the Narita Shinkansen from Tokyo to New Tokyo International Airport.

Detailed plans for five other Shinkansen lines are under way and general surveys have been completed. Twelve other lines are proposed; preliminary surveys for some of these have been made. Progress continues on the undersea tunnel between Honshu and Hokkaido and suspension road-rail bridges between Honshu and Shikoku.

Two types of trains are operated. HIKARI trains stop only at principal stations, connect Tokyo and Shin Osaka in 3 hours 10 minutes, and, on the fastest runs, take only 6 hours 40 minutes for the trip between Tokyo and Hakata. KODAMA trains serve all intermediate

stations, with typical travel times of 4 hours 14 minutes from Tokyo to Shin Osaka and 4 hours 24 minutes from Shin Osaka to Hakata. In the peak period, as many as 255 trains are operated a day, 138 HIKARI and 117 KODAMA.

A seven-car multi-purpose inspection train is operated in the daytime on the same schedule as that of passenger trains, to inspect, detect and measure irregularities of both track and electric facilities. It is run once a week on the HIKARI schedule and once every three months on the KODAMA schedule. Data collected are analyzed by computer to draw up the maintenance work schedule.

Routine maintenance work is performed at night after regular service ends. Major projects are done on selected nights about six times per year, when morning trains are cancelled and service resumes shortly afternoon.

Track condition is also inspected by daily patrol on foot and by recording devices carried on regular trains.

The various aspects of operation, particularly safety, on the entire line between Tokyo and Hakata are monitored by the General Control Center in Tokyo. The functions performed are:

1. *Train Dispatch.*—Keeping an eye on the CTC (Centralized Traffic Control) indication board and the control panel, the dispatchers monitor train movement and provide vital information to all the stations and trains on the line and give necessary instructions. In case of an incident or a natural disaster, or when the train schedule goes out of order due to weather conditions (wind, rain, or snow), they control train operation, using CD (Character Display) and GD (Graphic Display) units and make arrangements for restoration work.

2. *Railcar Dispatch.*—Using the wireless train telephone, these men inform train drivers and railcar inspectors of changes in assignment, give advice on emergency steps to be taken in case of car disorders and make arrangements for car replacement. When occasion demands, they instruct a car depot to take in the car for repair. In addition, operating the GD unit of COMTRAC, they input changes in operations and use other data for planning purposes.

3. *Electric Power Dispatch.*—Using the CSC (Centralized Substation Control) indication board and the control panel, these dispatchers monitor and control the electric power supply for train operation, remotely operating the equipment in the frequency-changing substations (3), substations (36), and sectioning posts (64) located along the line. Once an incident or a disaster takes place, instructions for securing alternative source of power and restoration work are promptly given. They also have the important function of suspending power during periods of daily maintenance, the plans for which are coordinated with other dispatchers concerned.

4. *Signalling System Dispatch.*—These dispatchers monitor the performance of the signalling system, such as ATC (Automatic Train Control) and CTC, keeping an eye on the monitoring panel, and when something abnormal is observed, they give the description of the disorder to the local dispatchers (in Tokyo, Shizuoka, Nagoya, Osaka, Okayama, Hiroshima and Kokura) as well as repairing instructions, consulting with other dispatchers in the Center.

5. *Passenger Information Dispatch.*—These dispatchers control all the data on passenger service and speedily transmit pertinent data to

stations, conductors' offices and Railway Operating Divisions by direct telephones, facsimile telegraph, wireless train telephone, and other means. When trains are delayed due to an incident or a natural disaster, they promptly process and transmit information on arrangement made for train connections or suspensions to keep passengers well informed.

6. *Communication System Dispatch.*—The main tasks of communications system dispatchers are maintenance and control of the electric communication system for train operation—the coaxial carrier transmission system for CTC and CSC, the wireless train telephone, the working time zone notifying system for protection of the maintenance personnel on night shift.

7. *Track Maintenance Dispatch.*—When these dispatchers detect faulty spots in the measurements made regularly by the "Electric Facilities and Track Inspection Train", or daily measurements of train sway taken by commercial trains, or the reports of track patrol men of the maintenance depots, they issue instructions for slowdown or stopping of trains and for emergency remedial measures. Their normal work is to adjust track maintenance operations during the nighttime zone when trains are not operated, consulting other dispatchers. In case of an incident or a disaster, they speedily issue instructions to the organs in charge of track and structures for restoration.

8. *COMTRAC (Computer-aided Traffic Control).*—The increase in the number and kinds of trains on the Shinkansen has come to overburden the work of the dispatchers and complicate their decision-making in adjusting train operation. The COMTRAC system, making use of the computer, is employed to complement this. These dispatchers monitor the performance of the computer and the peripheral equipment and operate the related apparatus by consulting other dispatchers concerned. They, in addition, control the automatic announcements at stations between Shin Kurashiki and Hakata and monitor the COMTRAC terminals installed at stations and conductors' offices along the Shinkansen line.

Electromechanical Laboratory (ETL)

Location: Tuskoda, Japan.
Date: January 20, 1983.

SUMMARY

The ETL was established in 1981 as the applied, industrial research and development laboratory of the Ministry of International Trade and Industry (MITI). In fiscal year 1983 ETL had $40 million and employed 2800 persons of whom 2000 are researchers. The current areas of research are electronics, information processing, energy and standards. Research results are reported into the scientific literature.

Dr. Itarn Todorik, Director of the ETL, welcomed the delegation and introduced the following members of the staff, who conducted presentations and tours:

Dr. Kohel Sato, Deputy Director;
Dr. Shigeru Maekawa, Research Planning;
Dr. H. Kashiwagi, Electronic Computer Division;
Dr. S. Wakamatsu, Automatic Control Division; and
Dr. D. Kato, Radio-Opto-Electronics Division.

DISCUSSION

The delegation visited three of the fourteen research divisions of the ETL.

The Electronic Computer Division has played an important role in the research and development of information processing techniques. This division has developed computers through the various states of technology including a time shared system and a hybrid computer system. The present major research interests of the Electronic Computer Division are data-flow digital computer systems, large scale memory systems, man-machine interface systems, and image processing techniques. Josephson computer switching technology is an area of interest. The division is using the direct bonding system and expects to achieve switching times in the range of one to ten pico-seconds.

The delegation visited the robotics laboratory and saw demonstrations of several developmental robots. The primary thrust of this division is to develop robots to work in environments that are not well suited to humans. Three criteria are of general interest in such situations: (1) the mobility and locomotion of the robots; (2) the sensory capability of the robots; and (3) the problem resolution capability of the machines. Early robots developed by this unit could operate hand tools, tools such as the auger, saw and a hammer, very much as a human would. Later developments created a robot with three fingers of considerable dexterity so that the three-fingered hand could, for example, rotate a batan or tighten a nut onto a bolt. Such devices go well beyond the basic positioning and moving functions of most industrial robots.

Among the prototype demonstration robots are the MELDOG which attempts to replicate the functions of a seeing-eye dog for blind persons, an Omni-directional automotive unit which has the capability of moving in all directions including perfect circular rotation which has application in many other robots, a robot to serve as a nurse's aide for moving seriously injured or invalid patients to and from wheelchairs, tables and beds, and finally, a film was presented showing an automobile that had been instrumented with a robot to drive the car. This car was able to detect obstructions in the road and go around them or to simply stop in front of them.

The Radio-Opto-Electronics Division illustrated their research in applying laser technology to medical problems. Thus far, laser technology has been successfully applied to cancer of the retina, rectal cancer and stomach cancer. A form of photo-chemo therapy has been used with good success in those particular maladies.

Briefing and Tour of Tsukuba Space Center, National Space Development Agency of Japan

Location: Tsukuba, Japan.
Date: January 20, 1983.

SUMMARY

The delegation was welcomed by Dr. Masao Yamanouchi, President of the National Space Development Agency (NASDA). NASDA was established on October 1, 1969, as the nucleus of Japan's space development effort in order to promote space development and utilization for peaceful purposes. The major activities of NASDA include development, launching and tracking of satellites and satellite launch vehicles and development and consolidation of sofeware, equipment and facilities needed for launching and tracking. In addition to the NASDA development activities, the development and launching of scientific satellites is being conducted by the Institute of Space and Astronautical Science.

NASDA is responsible for development activities and takes over tasks when the basic studies and technology have reached the stage at which the satellite or experiment can be developed. Generally, all national experiment or research organizations which want to utilize a planned satellite should conduct the basic research with their own funds.

DISCUSSION

The discussion and tour of the Tsukuba Space Center was led by Dr. Uda, Director.

Funding for Japanese space activities are divided between the National Space Development Agency (NASDA), the Institute of Space and Astronautical Science (ISAS), and others as follows:

[In millions of dollars]

	1982	1983
NASDA	381	390
ISAS	56	65
Others	31	33
Total	468	478

The major functions of the Tsukuba Space Center include:

1. Serving as the nerve center for Japan's satellite tracking data acquisition and command system composed of the NASDA stations at Katsuura, Okinawa and Masuda, the downrange stations, and the University of Tokyo's station at Kagoshima;
2. Performing a variety of tests on components of satellites and rockets as well as complete satellites; and

3. Serving as the technological information center for space development to process various technological calculations with large-scale computers and to process, store, and provide informational materials related to development; and utilizing various test facilities, to train and develop capable personnel for space activities.

To facilitate the performance of these functions, the following equipment and facilities are operated by the Center:

Computers.
Magnetic test facilities.
Acoustic test facilities.
Shock test machines.
Vibration test machines.
Centrifugal acceleration test machines.
Electromagnetic compatibility test facilities.
Satellite attitude control simulators.
Space simulation chamber.
Precision centrifuge.
Satellite mass properties measuring device.
Space vehicle flight simulator.
Gimballed engine actuating system test equipment.
Control system analyzer.
Tracking and control network operation and data processing system.

The delegation toured a new Anechoic Chamber which is in the process of being completed and will be used for antenna system tests. Other facilities which were viewed included the Space Simulation Chamber and Satellite Integration Test Facilities. The delegation also viewed the flight unit of the Communication Satellite—26 which is planned for launch in the near future.

NASDA officials noted that although generally the government policy was to launch satellites on Japan's launch vehicles, in the future it may very well be possible to launch larger communication satellites and other business satellites on the Space Shuttle. They further noted that NASDA was performing space station studies in cooperation with NASA and if the United States decided to proceed with a space station program, Japan is very interested in future discussions regarding what role Japan could play.

Questions and Answers

Japan: We wonder where the present Administration is taking NASA and in what direction?

United States: We hope to get some commitment on the United States part with regard to a Space Station. It will take some time to complete definition studies and development would not begin for two or three years. The Committee on Science and Technology is on record supporting the United States establishment of a permanent manned presence in space.

United States: Have Japanese industries expressed an interest in manufacturing materials in space?

Japan: Interest is shown by Japanese industry.

United States: Is Japanese industry willing to put up money?

Japan: After budget estimates are completed we can respond to this question.

United States: There may be a need for world-wide participation in funding such a program.

Japan: Japan will cooperate and make an investment commensurate with participation. Japan would need assurance for the long term utilization of a space station.

United States: Japan is pursuing a policy of independent space development which could lead to decreased purchase of United States space technology.

Japan: This is an issue of strong debate within Japan which is still going on. However, our policy is two pronged. Japan is interested in launching small satellites. There is a large gap in propulsion capability. Japan would depend on United States for launching large systems.

United States: Would Japan industry be willing to contribute to funding a space station?

Japan: We have a policy where Japan private industry could develop a satellite and then request NASA to launch. To ask Japan industry to cooperate with NASA—a government agency—in a space station is different and would require a new policy.

United States: With regard to targeting space industry, does industry on their own decide or does the Japanese government encourage them to move in a certain direction.

Japan: It happens both ways—government to government and industry to industry. In space activities, funds can be pooled by government and industry.

EXPO 1985—The Japan Association for the International Exposition

Location: Tsukuba Science City, Japan.
Date: January 20, 1983.

BACKGROUND

Following the 1982 Knoxville World Exposition and the 1984 Louisiana World Exposition, the next exposition of this decade, Tsukuba Expo '85, will open in Tsukuba Science City on March 17, 1985. Japan has previously hosted two international expositions: the Japan World Exposition, Osaka, 1970 and the International Ocean Exposition, Okinawa, Japan, 1975. United States participation in both events was large scale and in each case the United States pavilion was highly popular, drawing large crowds.

DISCUSSION

The United States has agreed to participate in Tsukuba Expo '85 and the United States Information Agency is in charge of coordinating the United States exhibition. Currently, the scale of United States participation is based on a budget of $4 million, which would allow for a 1200 square meter exhibition. The Japan Association expressed the hope that the United States government would increase its budget for the exposition. Considering various factors—the relatively small size of the proposed U.S. exhibit compared to its pavilions in previous expositions in Japan, the design of the exposition site, the estimated attendance of 20 million visitors, the overall balance with other international pavilions—the Association expressed a strong desire that the Unted States increase the size of its pavilion at Tsukuba Expo '85.

The United States delegation expressed general support for increased participation by the United States.

Discussion With Faculty of Tsukuba University

Location: Science City, Tsukuba, Japan.
Date: January 20, 1983.

SUMMARY

Three members of the faculty at Tsukuba University met with the delegation for a discussion of science and mathematics education in Japan. The three educators were: Professor Kazukiko Nakayama of the Institute of Electro-Communication and Information Science, Professor Tatsuro Miwa, a specialist in mathematics education from the Institute of Mathematics and Professor Mamoru Kanda, from the Institute of Mathematics.

DISCUSSION

In the Japanese system of education there has always been an emphasis on mathematics which is considered one of the most important subjects in the curriculum. The Japanese Government supports science education centers, such as the center at Tsukuba, for the retraining of mathematics and science teachers. But there are diverse opinions on how best to teach science.

Computer aided instruction in Japan labors under the difficulty that Chinese characters must be used. This is a significant difference in comparison with other countries. It means that, by the ninth grade, the student must have learned 5,000 individual characters. These characters are not easy to show on a computer display, and it is only during the past 3 or 4 years that it has been done successfully so that it can be used in the elementary schools.

Learning game experiments have been used and the students seem very pleased with that approach. But it is difficult to determine any statistically measurable gains. What does appear to be some of the effects is that students who can use computers and learn at their own pace will make good progress; and slower paced students also seem to do better.

A question was asked about whether the philosophy of using computers in teaching is to use them as a tool for teaching mathematics skills, or to use them in order to teach the use of a new information system. In response, it was noted that at Tsukuba University all students must take a computer course as freshmen. This applies not only to engineering and science students, but also to students in such fields as fine arts. This is done because it is recognized that we have now become an "information intensive" society. It was also noted that in the U.S. the computer belongs to the science departments, whereas in Japan it belongs to the engineering departments, where the emphasis is on applications.

Students at the pre-college levels do have access to computers in some cases. In the vocational schools computers are supplied at Government

expense. For other schools it is still in the experimental stage, and the Government provides grants for the computers used in those schools.

The Tsukuba Professors were asked why, in their view, Japan is doing a better job of mathematics and science education. The consensus was that students see many more employment opportunities and better pay for those who pursue careers in those fields. A member of the U.S. side noted, however, that this is the same situation in the United States, but not with the same result.

Staff Visit to Tokai and Oarai

Location: Japan.
Date: January 20, 1983

SUMMARY

Staff visited nuclear fission and magnetic fusion facilities of the Japanese Atomic Energy Research Institute (JAERI) and the Power Reactor and Nuclear Fuel Development Corporation (PNC) at Tokai and Oarai.

DISCUSSION

The first facility visited was the Japanese magnetic fusion project JT–60 which is being constructed by the Joint Atomic Energy Research Institute (JAERI) at Tokai. The JT–60 device is a tokamak with a slightly larger cross section for both the donut-shaped vessel and the plasma than the TFTR at Princeton. The device will not burn a D–T mixture as will TFTR and it is significantly smaller in the donut (toroidal) cross section than JET, the European facility at Culham, England. JT–60 will cost $800 million and will have the capability for 20 megawatts of neutral beam heating from 7 injector units and an additional 10 Mw of RF heating. The prototype neutral beam heater has been run at 75 kilovolts while producing 40 amps of current for 10 seconds. This 3 megawatt heater was built for JAERI by Hitachi and one other manufacturer. The construction has been completed on the facility building, all the necessary concrete has been poured, and it is expected that hardware installation will being next month. The project start-up date for JT–60 is 1985. A list of key JAERI personnel is attached.

Reactor safety research at JAERI.—JAERI carries out nuclear safety research at the Tokai facilities as well. They are actively involved in three different safety programs with the NRC and one program (high burn-up) with DOE. The Director of the Nuclear Safety Center, Dr. Nozawa, was particularly interested in the Subcommittee report on the NRC Safety Research Program and which has been sent to him. The JAERI officials were anxious about the prospects for Clinch River and funding for the HTGR program, in addition to having a keen interest in the DOE Light Water Reactor Safety Research program. JAERI is building a $30 million LWR safety facility to complement their existing facilities and they are operating a heat exchanger loop called HENDEL for research to support their HTGR program.

PNC Facilities at Oarai.—The Power Reactor and Nuclear Fuel Development Corporation (PNC) fast breeder facilities at Oarai were also visited. Mr. Inoue, the General Manager of Reactor Operations, discussed their fast breeder program. The Joyo FBR was upgraded by 25 percent to 100 megawatts thermal and the modified reactor reached criticality in November, 1982. The PNC officials feel

that this higher power capability of Joyo will allow them to obtain better design data for the Monju reactor and commercial FBRs.

When a Committee delegation visited Japan 4½ years ago, the Japanese were encountering increasing local opposition to siting the Monju reactor. Now it appears that they have a site and their Nuclear Safety Commission (NSC) will probably give the go ahead for construction within the next few months. The site chosen is near Tsuruga which is directly north of Kyoto on the Sea of Japan. The Japanese heavy water reactor, the 165 MWe FUGEN, is located near there. The site preparation is a formidable task for Monju since it involves removing the side of a mountain on the Sea, consisting of roughly 2 million cubic yards of dirt and rock. It is worth noting that the Monju construction schedule for this 300 gigawatt plant has slipped roughly 4 years since this demonstration reactor (the Japanese reverse the terms demo and prototype) was scheduled, as of November, 1978, to come on-line by early 1986 and now its initial operation is scheduled for 1990. The institutional arrangements regarding the relative roles of the PNC and JAERI with regard to Monju have not yet been decided. There is general agreement that it will be difficult to maintain the present schedule given the site preparation that is required.

The Waste Mangement activities were described by the appropriate PNC director, who outlined the Japanese program. Chiefly because of seismic problems, the Japanese waste management program has a very different emphasis than the U.S. program, although the Japanese utilities felt that the passage of our Nuclear Waste Policy Act was a very important step. The present Japanese program calls for their version of monitored Retrievable Storage (MRS) to be carried out with vitrified waste from reprocessing for several hundred years. In other words, the Japanese would not go to deep geologic disposal (on land or sea) until the glassified waste degrades to the radioactive levels near to that of uranium ore. The Japanese simply can't take the risk that an earthquake would impact a geologic repository which contained relatively hot material. The Director of the Waste Management Research program did not seem to be as conversant with the features of the U.S. nuclear waste bill as were the electric utility officials with whom the delegation discussed this topic in Tokyo.

GENERAL REMARKS

It is worthwhile to make some remarks regarding where the Japanese program is versus their plans of 4½ years ago, when the first Committee visit was made to Japan. At that time, the Japanese expected to have 30 gigawatts of nuclear generating capacity installed by fiscal year 1985. They have been slowed somewhat in terms of achieving these levels but it appears that they will have over 20 gigawatts by 1985, i.e., roughly 70 percent of their 1978 target. The Japanese government, utility and PNC officials generally felt that the country is "over the hump" in terms of their difficulties with siting of nuclear plants, and the effectiveness of intervenor groups is on the wane. If this is the case, it would appear that the Japanese are back on track for a bullish decade of nuclear development in the 1980s.

All of the Japanese with whom the staff had discussions regarding nuclear energy at Tokai and Oarai were most concerned about Con-

gressional views regarding "U.S. prior consent" with regard to reprocessing of spent fuel which had been provided by the United States. They were very nervous about this issue chiefly because of the way the previous Administration had handled this question.

JAPAN ATOMIC ENERGY RESEARCH INSTITUTE (JAERI)

Dr. Kemmel Hirano, Chief, Reactor Safety Laboratory II, Division of Nuclear Safety Research, Nuclear Safety Research Center.

Yasuhiko Iso, Director, Fusion Research and Development Center.

Satoru Katsuragi, Ph.D., Head, Division of Nuclear Safety Research, Nuclear Safety Research Center.

Sigeru Mori, Executive Director.

Dr. Masao Nozawa, Center Director, Nuclear Safety Research Center.

Yoshizo Okamoto, Dr. Eng., Head, Division of High-Temperature Engineering.

Hisashi Sekino, Tokai Research Establishment Division of Administrative Services Section.

Susumu Shimamota, Dr. Eng., Chief, Superconducting Magnet Lab, Division of Thermonuclear Fusion Research.

Dr. Kanji Tasaka, Senior Research Engineer, Reactor Safety Laboratory I, Division of Reactor Safety.

Ken Tomabechi, Dr. Eng., Head, Division of Large Takamak Development.

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Briefing on the History and Organization of Tokyo University and Its Research Computer Center

Location: University of Tokyo.
Date: January 21, 1983.

SUMMARY

The delegation was briefed by the President of the Tokyo University on the operations of the University. In addition, a discussion was held on the availability of scientific research computing capabilities and the advanced computer projects being sponsored by MITI.

DISCUSSION

Tokyo University is the oldest of the national universities in Japan. It was founded in 1877 and named an imperial university in 1886. Between that time and 1953, when it was reorganized along the American model, it accumulated a series of research institutes, observatories, and experimental stations throughout Japan. Currently, these associated institutions number 56. As a result, the operating budget of the university is quite large, almost $400 million a year. The current enrollment of the school is 14,426 undergraduate and 4,408 graduate students. The total faculty and administrative personnel number 8,552. The university has two major campuses in Tokyo, the Hongo campus and the Komaba campus in the Shibuya district.

An interesting point was made during the discussion. Engineering students outnumber the science students by a factor of 3 to 1 in the undergraduate school and by a factor of 1.5 to 1 in the graduate school; however, the Ministry of Education, which is responsible for funding the university, places a greater emphasis on providing research funds for the pure sciences rather than engineering. The engineering and applied sciences are supported primarily by MITI in separate laboratories and in industry rather than at the university. As a consequence the Fifth Generation Computer project and the Supercomputer project being sponsored by MITI are not being pursued at the universities. Thus, though the Chairman of the Advisory Council for both computer projects is on the faculty at the university, he is not performing any research supported by the projects.

The university has two computing centers; one is available to the general student population and is called the Educational Computing Center; the other is the Research Computer Center and is available primarily to the science and engineering faculties and students. The Tokyo University Research Computer Center costs about $5 million a year to operate. The cost to the students and researchers is subsidized by the Ministry of Education and is about one thirtieth the cost to commercial users. There are some 5 thousand users at Tokyo University and the associated schools in the Tokyo region that use

the computer center. The system is built around the Hitac-M200H made by Hitachi.

The Tokyo Computer Center was the first of seven national computer centers established by the Ministry of Education for university research computer users. The Tokyo Center was established in 1965 and was one of the driving forces in establishing a market for large Japanese-made central processors. The other centers are located at Hokkaido, Tokyu, Nagoya, Osaka, Kyoto and Kyushu.

A general discussion follows which dealt with the relative stature and pay for university professors in Japan. When a professor begins his career at the age of 30 or so, he is given a bonus in addition to the regular government salary. This advantage diminishes by the age of 45 to 55, when civil servants are being paid about 30 percent more. Of course, the private sector outstrips the university at all levels of experience. Another interesting facet of the university system is that there exist tenured research associate positions. This means that though they have neither the status nor responsibilities of professors, they do have job security in a university setting.

A brief discussion was held with Professor Moto-Oka about the advanced computer projects being sponsored by MITI. He views the advanced machines that will be constructed as having three major parts: an inference machine, a knowledge-base machine, and the man-machine interface complex. The two projects being sponsored by MITI address the first two parts, namely the inference machine and the knowledge base machine. The Supercomputer project is primarily hardware oriented, while the Fifth Generation Computer project will emphasize computer architecture and software development. The use of Very Large Scale Integrated Circuits (VLSIC) will lead to a parallel processing architecture for the computer. This arises because of the nature of the mass production process for VLSIC as well as the fact that cheap and complicated functions can be built into the hardware. The other part of the project is an attempt to incorporate artificial intelligence concepts into the software for these machines. The basic assessment of these projects is that the Japanese are not exploring dramatically new fields of computer science. However, because they have identified the problem clearly as a matter of policy and are addressing it in a way that integrates basic and applied research, they will undoubtedly push back the frontiers of the fields that they must explore.

Pre-College Science Education in Japan

Location: Tokyo University, Tokyo, Japan.
Date: Friday, January 21, 1983.

SUMMARY

At the suggestion of the delegation a meeting was held with seven students at Tokyo University. The students were in graduate programs at the university, and all of them had studied in the United States and spoke English well.

DISCUSSION

The purpose was to obtain their views about the differences in science education at the pre-college level in the United States and Japan. The students had attended and the subject studied were: Stanford (Aeronautical Engineering), Georgia Institute of Technology (Architecture), University of Michigan (Space Science), University of Dayton (Robotics), and MIT (two, both engineering).

The quality of pre-college science education in Japan is better than the U.S., they said. For example, calculus which is mostly begun at the college level in the U.S., is taught in high schools in Japan. The same is to a lesser extent true about college-level science education. For example, quantum mechanics is given in the junior year in college. But at the graduate level a U.S. education is better—it is a better experience for the students. One of the problems recognized in Japan is that 10 years after an individual receives a Ph.D., the U.S. student, on the average, is clearly better than his Japanese counterpart, and no one knows why this is so.

The motivation for students in Japan to take up science or engineering was discussed, with several factors suggested as being important. Some of the students said that they were motivated by an interest in working on industrial problems, and two had already had discussions about joining specific firms, in this case Sony and Nippon Electric Company. Some noted that frequently the equipment available for research in industry laboratories was significantly better than in the universities. Others noted the importance of starting salary for engineering students. Although Japanese students can expect to start at $12,000, an annual bonus of equal size brings the starting level to $24,000. Several of the students noted that they were surprised that the average starting level in the U.S. of $30,000 did not attract more students to engineering careers in the United States.

The role of other individuals in encouraging Japanese students to pursue a career in engineering or science was reviewed. The students noted that teachers do play a role, but that their role is strongly focused on the need to pass university entrance examinations. For this group of students the fathers' career and interests play a strong role. Most

had fathers who were professionals in such fields as engineering, university teaching or industry. It was noted, however, that the British tradition of son following father is not a strong factor in Japan and that students in the physics department, for example, include many from other backgrounds such as farming. The role of computers and their availability to young students was only considered moderately important, and none of the students personally owned a computer. The architecture student provoked some amusement by stating emphatically: "I hate computers".

A delegation member asked whether, in general, there was a shift occurring away from applied science toward basic research. One of the professors present observed that he did not believe so and that, in his view, Japanese engineering education may be stressing basic science too much.

Plant Tour and Briefing at the Zama Assembly Plant of the Nissan Motor Company Ltd.

Location: Tokyo, Japan.
Date: January 21, 1983.

SUMMARY

The Zama Plant is one of Nissan's five major assembly plants. It was opened in 1965 as a truck assembly plant. Since then, extensive new facilities were added for the production of passenger cars and assembly of trucks was transferred to the Kyushu Plant when it opened in 1977.

Currently the Zama Plant is devoted to the assembly of two models: the Nissan Sunny (Sentra) and the Nissan Silvia/Gazelle (180SX/200SX). The production rate is 35,000 units per month.

Assembly is highly automated, particularly the body assembly phase. Of the 3000 spot welds needed to assemble the body, 97% are accomplished by 124 robots. These are built both by Nissan and by Kawasaki under license from Unimation, a U.S. firm. These allow sufficient flexibility so that production need not be interrupted when new models are introduced.

The plant contains 800,000 sq meters of floor space. The assembly line is 2.4 km long. Three functions are performed: automobile assembly, tool and machine design and manufacture, and storage and delivery. Employment is 6,200 of which 5,000 work in the assembly areas. Current operation includes two 8 hour shifts, five days per week.

DISCUSSION

The manufacture of Nissan cars begins at the stamping shop where rows of presses shape sheet steel into bodies, floors and other panels.

Pressed steel panels are welded and assembled with the latest in precision welding equipment. The assembled body is washed and its surface is treated with phosphates before going through the painting booth.

Assembled bodied are dipped into a primer tank for cation electrodeposition painting to improve rust resistance. Then, the surfacer is applied by auto electrostatic spray, followed by the color spraying or finishing coat, which give the car high luster.

Windshields, front grilles, instrument panels, seats, and other fittings are installed with care and precision as bodies move down the trim line.

The power train is equipped with axles and suspensions as it moves along the floor-type conveyor. The engine is raised to the body when the conveyor comes to the engine mounting area.

Vehicles are provided with tires, oil, and water. After the lights are tested and adjusted, cars roll off the line under their own power.

As cars come off the assembly line, brakes and wheels are adjusted and aligned. Instruments are given a final check and exhaust emission

tests are conducted with the aid of computerized analyzer before they are pronounced ready for the market.

Finally, the leak test is carried out with four tons of pressurized water employed per car to ensure water tightness.

Major sub-assemblies such as engines, axles, steering units, and transmissions are sent from the Yokohama, Yoshiwara and Kyushu Plants, along with parts and components provided by other plants, affiliated firms and suppliers. Equipped with the latest in automated machines and labor-saving equipment, the Zama Plant is capable of producing up to 44,000 units a month. Some 60% of the vehicles turned out are earmarked for export. They are transported from the plant to an exclusive Hommoku Wharf and various public wharves for shipment to overseas markets.

The production line has been set up in such a way that a new production model can be introduced in the plant without shutting down the production line. At the time of our visit, the Japanese version of the mid-size VW was being planned for production in the plant.

APPENDIX A

Project Descriptions

At McMurdo

Lake physiological adaptations. *Bruce C. Parker and George M. Simmons Jr., Virginia Polytechnic Institute and State University.* Identification and evaluation of physiological adaptations of algae important in the ecology of lakes in southern Victoria Land. Project includes searching for algae specifically adapted to cold temperatures, high salinity, low light, low phosphate, and other nutrients, obtaining these algae in culture, and testing the extent of these physiological adaptations. During the 1981–1982 season five types of living stromatolites were identified in Lakes Bonney, Hoare, Vanda, and Fryxell. This season, a team will return to these lakes to determine how they contribute to the formation of geolipids—the precursors of fossil fuels. Four divers and other personnel will carry out the field work. Carbon dating techniques will be used on samples from previous years to determine the length of growth cycles.

Seasonal movements and interactions of the Weddell seal and the antarctic cod in McMurdo Sound. *Donald B. Siniff, University of Minnesota.* One objective of the 1982–1983 austral summer project is to learn more about the interaction between the Weddell seal (*Leptonychotes weddelli*) and its prey, particularly the antarctic cod (*Dissostichus mawsoni*). Fish from various locations will be caught and sonic tags used to obtain under-the-ice movement patterns of Weddell seals and the antarctic cod. Working near McMurdo Station, we will document distributional patterns of immature Weddell seals between October and February, monitor the movements of radio-instrumented Weddell seals into and out of McMurdo Sound, and census seals at Hutton Cliffs. In January and February we will be on an icebreaker to census and tag seals near the ice edge. Several remote receiving-recording stations will be placed on prominent landmarks around McMurdo Sound to monitor long-term movement of radio-tagged seals. (S–004)

The role of plycopeptide antifreezes in freezing avoidance of antarctic fish. *Aruthr L. DeVries, University of Illinois.* Living organisms adjust protein synthesis rates in response to environmental factors as a fundamental strategy for survival. During several seasons of research, we have discovered that all antarctic fish living in ice-laden shallow water possess either glycopeptide or peptide compounds that have protein antifreeze properties. Results from our experiments have indicated that there are eight different sized glycopeptides, which lower the freezing point of body fluids below the temperature of the seawater (−1.9°C). This season we will catch various species of native antarctic fish to obtain tissue and fluid samples. Using these samples, we will determine the distribution of the different glycopeptides in all body fluids. We will also investigate whether intestinal glycopeptide antifreeze originate in the intestines or are absorbed from the blood. Continuing past experiments, we will study the relationship of the glycopeptide structure to its function. A comparison of how the antarctic fish *Pagothenia borchgrevinki* and the Atlantic fish *Microgadus tomcod* regulate levels of glycopeptide antifreezes will be conducted. While the antarctic fish maintains constant levels of the antifreeze compound in the uniform cold of antarctic waters, the tomcod produces different levels of antifreeze, correlating with the seasonal variation of temperature in its environment. (S–005)

Population biology of south polar skuas. *David G. Ainley, Point Reyes Bird Observatory.* Although the breeding biology of south polar skuas, one of six major avian species of the pack-ice bird community in Antarctica, has been investigated by several researchers, our study focuses on population structure and demography. Surveys during paste austral summers indicated that south polar skuas begin to breed between ages 5 to 9 and that breeding pairs stay together and maintain their breeding territories for as long as 15 years. Our research also suggests that these birds may survive for 35 years or more, although the population's age structure is irregular and affected by environmental fac-

tors. We will return to Cape Crozier to complete a survey of breeding areas started last season. We will also extend our survey to Cape Evans and the coast near Marble Point to look for previously banded birds and estimate survival, longevity, and emigration. (S–013)

Endolithic microorganisms in ice-free valleys: primary producers in the Antarctic desert ecosystem. *E. Imre Friedmann, Florida State University.* We will continue our study of the microbial flora living inside rocks in the ice-free valleys near the Asgard Range and in Beacon Valley. Our research includes lichen taxonomy, the chemistry, leaching, and biological weathering of rocks, nonphotosynthetic endolithic bacteria, micrometeorology, and the yearly accretion of nitrogen in rocks. (S–015)

Factors influencing the growth and development of sea ice microbial communities. *Cornelius W. Sullivan, University of Southern California.* Annual sea ice is a unique habitat for underice microbial communities, dominated by diatoms but including algae, bacteria, and protozoans. At the end of the summer the melting sea ice suddenly releases a surge of these physiologically active microorganisms into the water column and provides the basis for the subsequent phytoplankton blooms and a rich source of protein for pelagic grazers. This season we will investigate the factors influencing the growth and development of the sea ice microbial community. We are interested in the relationship between algal and bacterial components of this community and believe that the ice bacteria, which may be more active and have higher growth rates than other bacteria, in the water column enable high algal standing stock to build up in the sea-ice lower layers. Perturbation studies will be conducted in McMurdo Sound to determine how light influences the growth rate of ice algae and how bacterial growth may be coupled to algal production. In addition to these field tests an environmental incubation chamber will be used to mimic light, temperature, and salinity features associated with the ice microenvironment (S–039)

Trace metal and nutrient behavior in the smaller lakes and meltwater streams of the antarctic ice-free valleys: Lakes Fryxell, Hoare, Miers, and Joyce. *William J. Green, Miami University.* The lakes of southern Victoria Land's ice-free valleys provide ideal conditions for investigating biogeochemical processes occurring in natural waters. They occupy enclosed basins, have a wide range of water chemistries, and are fed by only one or two meltwater streams during 6 to 8 weeks in the austral summer. We will begin a systematic study of the chemistry of Lakes Fryxell, Hoare, Miers, and Joyce. To gain more information on how trace metals are transported, removed, and remobilized in aquatic environments, we will establish trends in trace metal residence time. We will also investigate changes in biologically important elements as a response to changes in chemical conditions and determine which elements are present in concentrations and forms likely to be toxic to aquatic organism. Chemical data from meltwater streams, ice cover, and sediments will contribute to a general understanding of the trophic states and geochemical evolution of antarctic lakes. Because the lakes are isolated and can be studied as an entire system over a short period of time, they can provide a complete set of chemical data to be used for testing equilibrium and dynamic models of trace element and nutrient behavior. Our data will also add to the understanding of local biology, geology and climatology. (S–041)

Geodetic and upper-atmospheric studies using satellites. *Arnold J. Tucker, University of Texas.* At McMurdo Station we will operate and maintain a geodetic satellite observatory to collect dual-frequency doppler data from polar-orbiting satellites. These satellites transmit similar data to South Pole Station on specific orbits, and data from both stations will help determine the spatial and time variations of the ionosphere and provide geodetic positioning controls. The study of variations in the earth's magnetic field at a 1000-kilometer altitude will be augmented by telemetered magnetometer data acquired from other satellite passes. (S–051)

Late Cenozoic glacial history. *George H. Denton, University of Maine.* Research suggests that the marine ice sheet of West Antarctica expands to the edge of the continental shelves in the Weddell, Ross, and Amundsen Seas during glacial periods and recedes rapidly from these shelves during warm interglacial periods. Our research will focus on the late Quaternary history, the apparent instability of the marine-grounded ice sheet in West Antarctica, and, during the same geologic period, the apparent stability of the terrestrial ice sheet in East Antarctica. We will map glacial deposits in the ice-free valleys of southern Vic-

toria Land. Our work will focus on the upper Taylor Valley, Marshall Valley, Quartermain Range, and Asgard Range. Some of our findings will be used to refine a three-dimensional ice-sheet reconstruction for the last ice-age maximum. Research results from this season along with data acquired during the 1981–82 austral summer in northern and southern Victoria Land will refine knowledge of the Quaternary glacial-interglacial era of the West Antarctic Ice Sheet. (S–056)

Volcanic geology of Marie Byrd Land and its relationship to glacial and tectonic history in West Antarctica. *Wesley E. LeMasurier, University of Colorado, Denver.* Working in the McMurdo Sound-Ross Sea area, we will collect hyaloclastite, tufflike deposits formed when basalt flows under water and ice and is fragmented, to compare with analogous rocks from Marie Byrd Land. We plan to visit Minna Bluff, Turks Head, Beaufort Island, and possibly Franklin Island. Hylaclastites associated with pillow lavas (pillow-structured lavas presumably formed under water) from areas like Turks Head will be compared with hyaloclastites not associated with pillow lava from Marie Byrd Land. We will interpret the glacial and volcanic history recorded in the deposits. (S–073)

Contemporary geomorphic processes in ice-free valleys. *Michael C. Malin, Arizona State University.* Scientists have studied the geological and geomorphological history of the ice-free valleys of southern Victoria Land but have not addressed in detail the nature and rate of ongoing physical and chemical processes. We will examine wind erosion, desert pavement formation, chemical and physical modification of rock materials, and the relationships of these processes to landform development. One goal is to provide information for a variety of timescales, beginning with 2 months and continuing up to 20 years. Each site and the materials removed at selected intervals will be documented. We will use such analytical techniques as x-ray diffraction, optical inspection and mineralogical analysis, particle-size distribution and other sedimentological methods, and topographic and micro-topographic meteorological modeling. Scanning electron microscopy will play an important part in studying surfaces (exposed and freshly created) and crystal interfaces, as we attempt to identify initial phenomena associated with abrasion and physical and chemical alteration of rock material. The information we acquire should help in understanding how these valleys were formed, how they are changing, and how to predict the evolution of the region. (S–074)

Petrology and regional geology of early to middle Paleozoic magmatic rocks. *Edmund Stump and John Holloway, Arizona State University.* In northern Victoria Land, two chemically similar but temporally different groups of granitoid intrusions and an occurrence of extrusive rhyolite have been identified. Continuing last year's work, we will collect samples for laboratory analysis along the coast of northern Victoria Land at such locations as Moubray Bay, Tucker Glacier (west of Cape Hallet) and Spatulate Ridge, and along the coast from Tinker Glacier to Terra Nova Bay. We want to determine if the groups are chemically distinct and whether they were intruded continuously during the early to middle Paleozoic or in two episodes as limited data suggest. Laboratory investigations include petrography, mineral microprobe analysis, major- and trace-element geochemistry, and isotopic studies to characterize both types of rock groups. The project will extend our understanding of orogeny in the Transantarctic Mountains during the early to middle Paleozoic. (S–076A)

Petrogenesis of the McMurdo Volcanic Group and the nature of the subcontinental mantle. *Philip R. Kyle, New Mexico Institute of Mining and Technology.* Studies of midocean ridge basalts, particularly along the Mid-Atlantic Ridge and its extension into Iceland, have indicated that the Earth's mantle may be heterogeneous. Recent models have suggested the subcontinental, lithospheric mantle along the Transantarctic Mountains is enriched in rubidium and has a high strontium isotopic ratio. The McMurdo Volcanic Group basanites contain ultramafic nodules, some of which may have an upper mantle origin and provide a way of assessing the nature of the mantle in the Ross Sea area. Ultramafic and crustal inclusions found in the basaltic zones along the foothills of the Royal Society Range and around McMurdo Station will be collected for laboratory studies. We will examine mantle-derived inclusions for geochemical heterogeneities that have been proposed for the subcontinental lithospheric mantle along the Transantarctic Mountains. In one location evidence of mantle metasomatism has been found, but we will be searching for other instances of this formation. To understand the distribution, chronology, and petrogenesis of Erebus and Melbourne volcanic province rock suites, we will map and sample late Cenozoic alkali

volcanic rocks from the McMurdo Volcanic Group. We will also go to Mt. Erebus to continue surveillance of current volcanic activity and map around the summit flanks of the volcano and at Fang Ridge to evaluate the relationship of the volcano's geologic history to its current activity. (S–081A)

Magnetostratigraphy and sedimentology in ice-free valleys and McMurdo Sound. *Donald P. Elston, U.S. Geological Survey, Flagstaff, Arizona.* In an effort to decipher different aspects of late Cenozoic glacial history of the dry (ice-free) valleys and the Ross Sea, we will conduct stratigraphic, paleomagnetic, and sedimentologic investigations in eastern Taylor Valley, southern Victoria Land. Our work will concentrate on the stratigraphic and magnetostratigraphic correlations of subsurface and surface deposits underlying a late Pleistocene Ross Sea drift. During a similar project in 1980–81, we drilled to a depth of 45 meters on a ridgeline in central Taylor Valley and discovered a sand body in this core and in surrounding outcrops. It may be possible to correlate the relationships between the terrestrial history of the dry valleys and the Transantarctic Mountains and the marine glacial history of the Ross Ice Shelf to global climate changes in the late Cenozoic period. We will complete eight 40- to 60-meter deep drill holes with two to three contingency holes in Taylor Valley. This work, which will be a joint U.S.-New Zealand project, will complement regional map studies by other U.S. investigators and develop a historical framework for an interval, which includes part of the Pliocene and most of the Pleistocene periods. (S–099)

Cosmic ray intensity variations. *Martin A. Pomerantz, Bartol Research Foundation, University of Delaware.* Cosmic rays provide a powerful tool for studying exotic astrophysical processes that occur on the sun and in its far reaching atmosphere that controls space near Earth. The antarctic monitoring stations are crucial for probing interplanetary plasma dynamics through observations of variations in relativistic (over 1 gigaelectron-volt) galactic cosmic rays. At McMurdo and South Pole Stations, we will continue our observations of cosmic radiation on a year-round basis and collaborate with the magnetospheric cusp program. Our objective is to obtain high quality observations with the ultimate time resolution that has been attained by other upper atmosphere programs at U.S. antarctic stations. (S–109A)

Katabatic winds. *Gerd Wendler, University of Alaska.* Katabatic, or gravity-driven, winds strongly influence the climate of Antarctica. To improve our understanding of these winds, three automatic weather stations were set up between Dumont d'Urville (on the coast) and Dome C (1,000 kilometers inland) to collect data for comparison with existing theoretical models. This study is a collaborative effort with Professor Poggi of France, who is establishing weather stations in and around Dumont d'Urville. We will continue to investigate blowing snow and its effect on katabatic winds. Vertical profile measurements of windspeed, direction, temperature, and dew point will be taken between Dome C and Dumont d'Urville Station and at South Pole Station. (S–277)

Microphysics of cloud-aerosol interactions. *V. K. Saxena, North Carolina State University.* Large-scale motions determine when and where clouds will form and what their moisture content will be, but the microphysical processes that lead to ingestion of nuclei-rich air into the clouds are crucial in determining whether a cloud will produce rain, snow, or ice. In Antarctica coastal cloud-aerosol interactions are important in the summer hydrology of the coastal regions, the scavenging mechanisms in coastal clouds, and the chemistry of precipitation that accumulates on the surface. In November 1980 we collected samples of coastal-cloud water that showed evidence of biogenic material. Because of this discovery we have a new understanding of the microstructure of antarctic clouds and of the significance of biogenic sources. We think the source of this material is plankton in the southern ocean, which gets into the air when bubbles break on the surface of the sea. To test this hypothesis we will sample snow, ocean water, and cloud water from an aircraft capable of penetrating clouds. Data analysis will emphasize the microstructure of coastal clouds and the physiochemistry of aerosols that help to form clouds. (S–282)

Collection and analysis of automatic weather station data. *Charles R. Stearns, University of Wisconsin.* Although information taken from satellites on antarctic weather patterns is valuable, surface data are needed for confirmation. Automatic weather stations (AWS) measure surface pressure, air temperature, wind speed, and wind direction and transmit the data to satellites for interrogation by ground stations. To obtain reliable year-round surface data, we have installed

AWS units around McMurdo Station and at Dome C. Byrd, Siple, and Dumont d'Urville Stations. This season we will service and recalibrate these units. One weather station at Arrival Heights near McMurdo will be moved to the Ross Ice Shelf, and storage batteries and solar panels will be installed in the Siple AWS so that it can operate throughout the winter. Four AWS units will be installed for us by the British Antarctic Survey this season in the Antarctic Peninsula region along the Weddell Sea. The data from these stations will be used to make case studies of barrier winds, foehn wind storms, terrain effects, and ice transport from the Weddell Sea. (S–283)

Projects Arriving McMurdo in January to Board Polar Star

Plankton and the marine geochemistry of radium, germanium, and barium. *Kent Fanning, University of South Florida.* Like the distribution of nutrients (particularly silica) dissolved in seawater, concentrations of radium–226, germanium, and barium are usually depleted in surface waters and enriched in deep waters. Planktonic organisms may simply store these elements in skeletal structures, because they have no known biochemical functions. Because the southern ocean has large deposits of biogenic silica and is a major source of deep waters for the rest of the world, planktonic processes (related to the uptake of silicon and the three other elements) are important for determining the initial concentrations of biologically reactive substance in other areas of the ocean. While aboard the USCGC *Polar Star* we will collect seawater samples along the ice edge in areas of high biologically activity. These samples will be filtered for phytoplankton and zooplankton and will be used to estimate the uptake rates of radium–226, germanium, and barium. (S–213)

Marine bird distribution in relation to krill in the East Wind Drift. *George L. Hunt, University of California, Irvine.* The East Wind Drift flows west along the antarctic coast, except where gyres in the Weddell, Ross, and Bellingshausen Seas divert it northward. Because little is known about the bird distribution in this region, during the circumantarctic cruise of the icebreaker *Polar Star* this season we will examine the distribution from Victoria Land (near the coast of Wilkes Land), Enderby Land, and Queen Maud Land to the Antarctic Peninsula. We will make a series of continuous 10-minute transects, supplemented by helicopter transects along the ship's cruise track. Data on bird species composition and numbers along with marine mammal and krill swarm distribution, ice conditions, and salinity-temperature measures will be collected. We will also investigate primary productivity, krill swarms, and the presence of birds and mammals in order to better understand the irregular distribution of higher marine vertebrate in relation to krill distribution. These data on the composition and distribution of the marine birds will provide information for an antarctic marine ecosystem model. (S–021)

Circumpolar analysis of the marine bird and mammal faunas of the pack ice. *Joseph R. Jehl, Jr., Hubbs-Sea World Research Institute.* During the circumantarctic cruise of the Coast Guard icebreaker *Polar Star*, we will document the distribution of marine bird and mammal faunas of the pack ice region, which until recently has been largely unexplored. An underwater acoustical device will enable us to monitor the presence of submerged mammals and to determine the relative effectiveness of visual and acoustical censusing. To extend our studies of killer whale biology in a geographic area for which no information is available, we will use hydrophones to record vocalizations and photography to document morphological variations. This information will help to clarify distribution, population structu.e, and the role of this predator. (S–034)

Censuses of seals in the eastern sector of antarctic pack ice. *Albert W. Erickson, University of Washington.* Increased demands for ocean resources will inevitably have an impact on the welfare of antarctic seal stocks. Besides direct exploitation of seals, commercial harvesting of krill and fish, biological contaminants acting directly or through the food chain, and physical impacts such as sounds may adversely affect the southern ocean seal population. Between 1967 and 1974 we extensively studied seals in the antarctic pack ice in order to develop a method for assessing seal population dynamics, to consider problems of stock discreteness, and to describe reproductive characteristics. This austral summer we will survey along the coast of East Antarctica, an area where censuses have not been conducted. The combined results of the earlier survey and this year's census will complete a circumantarctic assessment of seal abundance, distribution, and species composition. (S–044).

At Remote Locations

Meteoritics. *William A. Cassidy, University of Pittsburgh.* Meteorites are useful in investigating possible changes through time in the meteoroid flux at earth, measuring the cosmic ray flux in past eras, searching events in which asteroid parent bodies were disrupted, and defining the abundances and characteristics of pre-solar-system organic molecules. Because high concentrations of meteorites have been found in the Allan Hills region of Victoria Land, one team will continue meteorite searches at a principal concentration site there and at Elephant Moraine, a site 80 kilometers north of Allan Hills and 70 kilometers west of Reckling Peak. They will also visit two ice patches, one 90 kilometers west of the Allan Hills and the other 50 kilometers northwest of Elephant Moraine, to search for more meteorite sites. Because ice movement and ablation rate data and ice analysis increase our understanding of the way meteorites concentrate, a second team in the Allan Hills will do glaciology and extend a triangulation grid previously established. A third team will search for meteorites in the Thiel Mountains and at Pecora Escarpment. (S–058)

Stratigraphy and paleontology of the Gondwana rocks of southern Victoria Land. *Sankar Chatterjee, Texas Tech.* The Victoria (Permian and Triassic) and Ferrar (Jurassic) Groups of rocks are composed of a flat-lying, nonmarine sequence (the Beacon Supergroup) from Devonian or older to Jurassic in age. Our research will focus on the stratigraphy and paleontology of the Victoria Group because it was deposited before Gondwanaland broke up; the Ferrar Group, which marks the end of Gondwana sedimentation, will also be investigated. Working in the Allan and Carapace Nunataks of Victoria Valley, we will search for fossils of terrestrial vertebrates, emphasizing stratigraphic, taxonomic, and paleoecologic relationships. This region, which has not been searched for Gondwana fossils, may provide us with data to help resolve the controversy concerning the exact position and duration of contact (if any) between India and Antarctica. We will also study the source, origin, diagenesis, and environment of volcanic sediments of Gondwana rocks. Clay minerals will be used for detail interpretations of the provenance and paleoenvironment. (S–066)

At South Pole

Human immune responses during bioisolation. *Harold G. Muchmore, Oklahoma Medical Foundation.* Contrary to the accepted concept that virus shedding usually ends early in convalescence, we have found by examining throat swabs taken from South Pole residents that viral persistence and shedding probably continue over a prolonged period. Samples from the station residents will be collected again during this austral summer and the winter isolation period. We hope to demonstrate the virus's presence in the primary nasopharyngeal specimen, to measure directly posterior nasal mucosal temperature in the extremely dry, cold climate of the South Pole, and to assess the impact of climate extremes on nasopharyngeal mucosa by serial measurements of the functions of nasal secretory immune system. Radioimmunoassay (RIA) and enzyme-linked immunosorbent assay (ELISA) techniques will be used to detect viral antigens in frozen sera and in specimens of nasopharyngeal secretions. Successful immunoassays should confirm the persistence of parainfluenza virus shedding and increase our understanding of the epidemiology of virus infections and the patterns of human immune response. (S–007)

Long-period gravity and seismic observations. *Leon Knopoff and W. D. Smythe, University of California, Los Angeles.* Because Amundsen-Scott South Pole Station is a seismically quiet platform, ideal for ultralong-period seismic and gravity observations, we will continue to measure long-period oscillations of the earth using two ultralong-period seismometers (modified La Coste-Romberg gravity meters). Also from this station, located on the path of the Mid-Atlantic Ridge and the East Pacific Rise, phase velocities sensitive to the middle-mantle structure under an oceanic ridge can be studied. The station's location, its symmetric position between the oceans, and the low noise at the observation site favor observations of long period tides and free oscillations. Analysis will provide us with a better understanding of the deep structure and lateral inhomogeneities of the earth. (S–050)

Very-low-frequency wave observations. *D. L. Carpenter and J. P. Katsufrakis, Stanford University.* We are investigating the physics of the magnetospheric

cusp. In this region, solar wind plasma freely penetrates the magnetosphere and impinges on the earth's ionosphere, giving rise to a relatively localized region of particle precipitation and to a variety of plasma instabilities. Working with several other groups, we are attempting to define the characteristics of the southern polar cusp as well as to determine the morphology of substorm phenomena as they appear at the high-auroral-oval latitude of South Pole Station. Broadband very-low-frequency (VLF) wave data will be recorded; wave intensity in 10 selected narrowband channels will be sampled and recorded on a digital data logging system provided by the University of Maryland. While the Siple VLF transmitter is operating, we will make special ground recordings at South Pole in order to study how ionospheric changes affect subionospheric signal propagation between Siple and South Pole Stations. Ground VLF recordings, made when the Dynamics Explorer-1 satellite is operating over Antarctica, should provide important data for cusp and substorm phenomena investigations, and help determine the extent to which various classes of high-latitude VLF waves phenomena can penetrate the ionosphere. (S–100D)

Auroral imaging at Siple and South Pole Stations. *S. B. Mende, Lockheed Palo Alto Research Laboratory.* In 1980 our collaborators from Boston College (S–119) installed at South Pole Station a camera to monitor cusp auroral activity. This camera produces time-latitude "keograms" directly on film and provides a quick, easy method of finding the latitude of the cusp. We will continue to operate the camera this season and check the equipment for needed adjustments. The system will be maintained by South Pole personnel during the austral winter. (S–104A)

Solar observatory. *Martin A. Pomerantz, Bartol Research Foundation, University of Delaware.* Approximately 6 kilometers from South Pole Station, we operate a solar telescope. A computer system, acquired and programmed by our Swedish collaborators, guides the telescope, rotates the solar image, maintains the selected field of view, and controls an observation schedule, which automatically shifts from one solar feature to another and produces photographic exposures and other records. This austral summer we hope to use new ancillary equipment and continue observations of solar features called super granulations. We will also obtain a new series of full-disk doppler-shift measurements, which enable us to probe the sun's interior structure and dynamics. Specifically the observations should provide data for models of the sun's interior temperature structure, define the lifetime of specific modes of oscillations, provide critical information about excitation and dissipation mechanisms of oscillations, probe the nature of meridional flows in the solar convection zone, and test the nature of oscillations, with periods in excess of 10 minutes. To extend our understanding of the structure and nature of the sun's interior, we are interested in detecting and identifying gravity modes with precision similar to that already attained for acoustic modes. (S–109B)

Riometry in Antarctica and conjugate regions. *Theodore J. Rosenberg, University of Maryland.* A riometer, or relative ionspheric opacity meter, provides continuous data economically on temporal and spatial variations of energetic particle precipitation. We will inspect the riometers and digital recording systems at South Pole and McMurdo Stations. Also at the South Pole, we will install a 30-megaherz riometer and data multiplexer as part of the Lockheed Research Laboratory's prototype automatic geophysical observatory. (S–104B). A digital recording system will be installed at Siple Station, and another 30-megaherz riometer will be installed by Stanford University personnel (S–100B) at Palmer Station. The riometer measurements will provide information on particle precipitation and ionospheric perturbations associated with the cusp, auroral oval, and plasmapause regions of the magnetosphere. (S–111B).

Extended observations of solar oscilliations. *Robin Stebbins, Sacramento Peak Observatory.* The sun's normal modes of oscillation comprise a powerful diagnostic tool for studying a star's rotation, internal geometry, and internal physical processes. But, to be useful, the acoustic spectrum must be more highly resolved in frequency than is possible in a normal 12-hour observation period. Extended observations made at a polar site is one possible remedy to this difficulty. This austral summer we will use a compact, portable telescope to observe solar oscillations over several days at South Pole Station. Our observing technique analyze solar-limb darkening for brightness oscillations. Data, acquired for as many extended viewing periods as possible, will be sent to Sacramento Peak Observatory for analysis. These observations will help us probe the sun's interior about which there is little direct information. (S–121)

Aerosol transport processes. *Austin Hogan, State University of New York, Albany.* Several proposed theories relate climate change with variation of such physical properties as radiation transmission, conductivity, and cloud nucleation of the particulate matter suspended in the atmosphere. The ice in Antarctica acts as a sink and a temporary storage reservoir for particulate matter, certain gases, and vapors that precipitate from the air as it passes over the continent. Although the precipitation of these materials to the ice is important in maintaining the stability of several physical properties of the atmosphere, the precipitation mechanisms, which remove the material from the air, and the frequency with which the mechanisms act are not well understood. This austral summer from South Pole Station we will fly slow-rising meteorological balloons to measure the concentrations of ice crystals and aerosols and the variation of the wind currents to determine the circulation over the polar plateau. The measurements should enable us to form estimates of the ice's capacity as a sink for atmospheric contaminants. (S–255B)

At Siple

Very-low-frequency probing of the magnetosphere. *R. A. Helliwell and J. Katsufrakis, Stanford University.* We are continuing to investigate the response of the earth's magnetosphere to the injection of coherent very-low-frequency (VLF) waves. This response includes wave growth, spectral broadening, development of sidebands, triggering of VLF emissions, wave-wave coupling, and particle scattering. From recent experiences we recognize the need to operate the Siple transmitter near the 2–3 kiloherz range and increase the radiated power at those frequencies. To operate within this range and the station's power capabilities, we will double the length of the existing 21.4-kilometer dipole antenna; we also will raise the existing antenna above the level of accumulated snow. In 1983 we will transmit to such satellites as the Dynamics Explorer–1, ISIS–1, and ISIS–2, and we will support the SEEP (Stimulated Emission of Energetic Particles) experiment. By increasing the transmitter's radiated power capability we will be able to test newly designed wave-injection experiments. We will continue to do correlation experiments involving multiple techniques to study how various types of VLF waves scatter electrons into the ionosphere. As a part of particle precipitation studies, special subionospheric transmissions to Palmer, South Pole, and Halley Stations will be made. Continuous and synoptic broadband VLF recording will be carried out as required for long-term observations, plasmapasue studies, and correlative support of particular projects. (S–100A)

Riometry in Antarctica and conjugate regions. *T. J. Rosenberg, University of Maryland.* A riometer, or relative ionospheric opacity meter, provides continuous data economically on temporal and spatial variations of energetic particle precipitation. Riometer data help show features of solar particle entry into the magnetosphere and the dynamic processes of magnetospheric particle injection, drift, and modulation. Last season we installed three new riometers and a chart recorder at South Pole and two new riometers with a chart recorder at McMurdo Station. During the 1982–1983 season we will operate digital data recorders at the South Pole, McMurdo and Spile stations. The measurements are expected to identify previously undetected relationships in wave-particle interactions in the magnetosphere. (S–111B)

Atmospheric infrasound studies. *Charles R. Wilson, University of Alaska.* This season we will continue our observations of auroral infrasonic waves from Windless Bight on the Ross Sea. We also hope to install a new computer more powerful than those that have been used in the past. From our observations, we hope to gain more information on the source of infrasound. Measurements will be taken of all infrasound in the pass band from a 1 to 100 second period. During the winter a technician will analyse infrasonic signals daily. (S–108)

Geophysical Monitoring for Climatic Change

(By James T. Peterson, Director)

The primary NOAA responsibility for monitoring and analyzing the atmospheric constituents important for climate change rests with the Geophysical Monitoring for Climatic Change (GMCC) program of the Air Resources Laboratories. GMCC operates four observatories located in remote areas of the earth in order to detect changes in background concentrations of atmospheric trace

gases and particles which may result from human activities. The observatories are located at (1) Barrow, Alaska; (2) Hilo, Hawaii; (3) American Samoa; and (4) South Pole, Antarctica. In recent years, these observatories have been the means by which the scientific community has observed the episodic injections of volcanic debris into the stratosphere and the continuing build-up of atmospheric chlorofluorocarbons and carbon dioxide. In addition to the four remote baseline observatories, other measurement activities are (1) Dobson spectrophotometer measurements as part of a global WMO total ozone network; (2) monitoring of atmospheric turbidity and precipitation chemistry in a U.S. network of stations jointly operated by NOAA and EPA, which is a regional component of a larger WMO network; (3) the monitoring of CO_2 concentrations from 20 surface stations strategically located at remote sites on the globe; and (4) special measurements from Niwot Ridge and Boulder in Colorado. All of the above activities are coordinated from a central research unit which is part of the Environmental Research Laboratories (ERL) headquarters in Boulder, Colorado.

APPENDIX B

SOUTH POLE STATION PROJECTS

Project (title)	Event No.	Principal investigator institution	Summer	Winter
Immunity and Virus Shedding at the South Pole.	S–007	Harold G. Muchmore, VA Medical Center		X
Long Period Gravity and Seismic Observations at the South Pole.	S–050	Leon Knopoff, University of California, LA		X
Geodesy and Seismology	S–052A	Rupert B. Southard, U.S. Geological Survey		X
VLF Observations at South Pole	S–100D	John P. Katsufrakis, Stanford University		X*
Magnetic Field Investigations at Siple Station and South Pole Station.	S–101	L. J. Lanzerotti, Bell Laboratories		X*
Operation of Micropulsation Stations in the Antarctic and Preparation of a New Station for the Unmanned Geophysical Laboratory.	S–102	Laurence Cahill, University of Minnesota		X*
Photometer Observations of Particle Precipitation in Antarctica.	S–104A	Stephen B. Mende, Lockheed Palo Alto Research Laboratory.		X*
Automatic Geophysical Observatory in Antarctica.	S–104B	do		X*
A Study of the Midday Auroras at the South Pole Station.	S–106	S. I. Akasofu, University of Alaska		X*
Investigations of Cosmic Ray Intensity Variations in Antarctica.	S–109A	Martin A. Pomerantz, The Bartol Research Foundation.		X*
Solar Seismology at the South Pole: Studies of Solar Oscillations.	S–109B	do	X	
Riometry in Antarctica and Conjugate Regions.	S–111B	Theodore J. Rosenberg, University of Maryland.		X*
Auroral Imaging	S–119	Robert H. Eather, Boston College		X*
Extended Observations of Solar Oscillations	S–121	Robin Stebbins, Sacramento Peak Observatory.	X	
Ionosonde Studies of the Cusp Ionosphere from South Pole Station, Antarctica.	S–122	F. T. Berkey, Utah State University		X*
Ice Core Drilling—South Pole	S–150	Karl C. Kuivinen, University of Nebraska/ Lincoln.	X	
Core Processing at South Pole	S–170	Hans Oeschger, University of Bern	X	
Microparticle Analysis and Glaciological Interpretation of the 500-m Ice Core South Pole, Antarctica.	S–171	Ellen Moseley-Thompson, Ohio State University.	X	
Aerosol Transport Processes in the Antarctic	S–255B	Austin Hogan, State University of New York at Albany.		X*
Geophysical Monitoring for Climatic Change	S–257	James T. Peterson, National Oceanic and Atmospheric Administration.		X
Atmospheric Variability in the Concentrations of Trace Gases over Antarctica.	S–262	M. A. K. Khalil, Oregon Graduate Center for Study and Research.		X*
Measurement of the Column Densities of HNO_3, CF_2Cl_2, $CFCl_3$, and O_3 During the Antarctic Winter.	S–270	David G. Murcray, University of Denver		X*
Antarctic Tracer Experiment	S–284	Paul R. Guthals, Los Alamos National Laboratory.	X	
16mm and OMNIMAX Films "Portrait of Antarctica" (cancelled).	S–319	Jack Laney	X	

*No winter-over personnel, program responsibilities will be handled by other discipline/station personnel.

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APPENDIX C

THE WHITE HOUSE

WASHINGTON

February 5, 1982

MEMORANDUM FOR THE SECRETARY OF STATE
THE SECRETARY OF THE TREASURY
THE SECRETARY OF DEFENSE
THE SECRETARY OF THE INTERIOR
THE SECRETARY OF COMMERCE
THE SECRETARY OF TRANSPORTATION
THE SECRETARY OF ENERGY
THE DIRECTOR, OFFICE OF MANAGEMENT AND BUDGET
THE DIRECTOR OF CENTRAL INTELLIGENCE
CHAIRMAN, JOINT CHIEFS OF STAFF
DIRECTOR, ARMS CONTROL AND DISARMAMENT AGENCY
DIRECTOR, OFFICE OF SCIENCE AND TECHNOLOGY POLICY
ADMINISTRATOR, ENVIRONMENTAL PROTECTION AGENCY
DIRECTOR, NATIONAL SCIENCE FOUNDATION

SUBJECT: United States Antarctic Policy and Programs

I have reviewed the Antarctic Policy Group's study of United States interests in Antarctica and related policy and program considerations, as forwarded by the Department of State on November 13, 1981, and have decided that:

- The United States Antarctic Program shall be maintained at a level providing an active and influential presence in Antarctica designed to support the range of U.S. Antarctic interests.

- This presence shall include the conduct of scientific activities in major disciplines; year-round occupation of the South Pole and two coastal stations; and availability of related necessary logistics support.

- Every effort shall be made to manage the program in a manner that maximizes cost effectiveness and return on investment.

I have also decided that the National Science Foundation shall continue to:

- budget for and manage the entire United States national program in Antarctica, including logistic support activities so that the program may be managed as a single package;

- o fund university research and federal agency programs related to Antarctica;

- o draw upon logistic support capabilities of government agencies on a cost reimbursable basis; and

- o use commercial support and management facilities where these are determined to be cost effective and will not, in the view of the Group, be detrimental to the national interest.

Other agencies may, however, fund and undertake directed short-term programs of scientific activity related to Antarctica upon the recommendation of the Antarctic Policy Group and subject to the budgetary review process. Such activities shall be coordinated within the framework of the National Science Foundation logistics support.

The expenditures and commitment of resources necessary to maintain an active and influential presence in Antarctica, including the scientific activities and stations in the Antarctic, shall be reviewed and determined as part of the normal budget process. To ensure that the United States Antarctic program is not funded at the expense of other National Science Foundation programs, the OMB will provide specific budgetary guidance for the Antarctic program.

To ensure that the United States has the necessary flexibility and operational reach in the area, the Departments of Defense and Transportation shall continue to provide, on a reimbursable basis, the logistic support requested by the National Science Foundation and to develop, in collaboration with the Foundation, logistic arrangements and cost structure required for effective and responsive program support at minimum cost.

With respect to the upcoming negotiations on a regime covering Antarctic mineral resources, the Antarctic Policy Group shall prepare a detailed U.S. position and instructions. These should be forwarded for my consideration by May 15, 1982.

Ronald Reagan

APPENDIX D

The Antarctic Treaty

T. O. JONES

National and International Programs, National Science Foundation, Washington, D.C.

Science does not come immediately to mind as a prime consideration in international relations, but in Antarctica science has been the lever which pried loose a peaceful solution of national rivalries.

A brief review of the history of Antarctica over the past thirty years should help us to see how science has aided in bringing national aspirations into closer international harmony. When World War II broke out, the Antarctic was being rapidly cut up like a great pie by the interested powers—Argentina, Australia, Chile, France, New Zealand, Norway, and the United Kingdom—which had claimed wedges of antarctic territory. Belgium, Germany, and Japan all possessed potential rights by exploration. The Soviet Union, long preoccupied with the development of its hinterland and with European politics, indicated that its interests must be considered in reaching a settlement in Antarctica. The United States continued publicly not to recognize the territorial claims of other countries and to reserve its territorial rights in accordance with the policy, first enunciated by Secretary of State Charles Evans Hughes in 1924, that:

> The discovery of lands unknown to civilization, even when coupled with a formal taking of possession, does not support a valid claim to sovereignty unless the discovery is followed by an actual settlement of the discovered country.

Those concerned with antarctic affairs wondered whether or not the United States could long maintain this position.

World War II served only to further the disintegration of the integrity of Antarctica as a *terra nulla*. German military activities in antarctic waters showed how operations around Antarctica could dominate portions of the southern sea routes, particularly in the region of the Drake Passage. The United Kingdom's moves to

counter German activities and the inevitable rivalry with Argentina over these areas further complicated the problem. Only the preoccupation of the European powers in recovering from World War II allowed the antarctic problem to recede.

The United States in the decade after 1945 hoped to resolve its own dilemma on a proper stance in Antarctica by seeking some international solution to the problem. One object was the peaceful settlement of differences among the involved nations and another was freedom of access to carry on scientific investigations. Discussions with leaders in antarctic activities, including Laurence M. Gould, indicated that in the foreseeable future, the main resource in Antarctica would be its location as a site for fundamental research on geophysical problems. In the meantime, the United States undertook major expeditionary activities, such as *Operation Highjump* and *Operation Windmill*, under the leadership of Rear Admiral Richard E. Byrd and others.

These efforts carried U.S. aerial explorers over much of Antarctica. The prospect that these efforts would develop international accord or resolve the dilemma of our stance regarding a claim, however, did not presage success. Other governments with antarctic territorial interests were, at this time, reluctant to enter into international agreements on Antarctica as they were suspicious of U.S. intentions. Much of the force behind the U.S. expeditions came from the personal zeal of a few explorers, while the general attitude was one of indifference. It was obvious that something was needed which would develop a wider scale of interest in antarctic affairs in the United States—something which would create a national purpose to support a long-term presence in Antarctica and provide sufficient cause and reason to finance and support antarctic activities. The International Geophysical Year (IGY) did just this.

In the perspective of more than a decade since the IGY ended we can see clearly that the significance of the IGY in Antarctica was the commitment of national resources to the exploration of the continent and the opportunity it provided to obtain international accord on certain vital questions. The allotted time for the IGY was too short to do more than begin the exploration of Antarctica but the national expeditions to which governments committed themselves for the IGY continue today, twelve years later. Vicissitudes of budgets forced Belgium, Japan, and Norway to close their stations. Japan, however, was able to return in 1965 after a new capital commitment of millions of dollars to modernize its transpor

and the station. Norwegian parties took to the field in 1968–1969 for the first time since 1959. The Belgians still hope to reopen their station. None intend to drop out permanently. All of the other countries which participated in the IGY have expanded their efforts to varying degrees over the last ten years. Antarctica has become an item of national policy for all these countries. It is no longer just a dream in the mind of explorers.

The IGY Antarctic Program was the first large-scale international effort in which the needs of science dominated the relationships among the governments concerned. The scientific forum became the vehicle to reach accord on several critical non-scientific matters. The chief coordinating group was the Antarctic Committee of the Special Committee for the International Geophysical Year of the International Council of Scientific Unions (ICSU).

In this forum, scientific representatives spoke for their respective scientific communities with the tacit consent of their governments. The desire for a better understanding of our earth assumed ascendancy over the more parochial and divisive national objectives which had previously dominated antarctic affairs.

The critical issues on which accord was achieved were:

1. The distribution of stations
2. The meteorological telecommunications network
3. The exchange of data, results, and personnel
4. Freedom of movement to pursue scientific programs

These issues were contentious if approached from the point of view of national interest. But scientific requirements provided a neutral ground on wh. n to discuss them. Thus, for scientific reasons the Soviet Union and the United States resolved the matter of occupancy of the geographic and geomagnetic poles. New Zealand and the United States found *modus operandi* on Ross Island and at Hallett Station. The Australians accepted, albeit guardedly, the presence of Soviet stations in East Antarctica. A network of radio stations and procedures were agreed upon for the relay of scientific traffic and the great volume of meteorological data needed for operational purposes in particular. Although these arrangements were never embodied in any formal agreement, the present-day array of antarctic stations remains basically the same. Changes that have occurred have been dictated by the requirements of science and the need to make possible the exploration of the remaining unknown areas. The communications network has survived with only a few changes and has become a recognized system within the World Meteorological Organization.

The exchange of certain data and results was actually formalized into a series of ICSU agreements, while freedom of movement of scientists was assumed as a principle and observed as a matter of tacit consent.

The importance of the settlement of these matters in the Special Committee for the International Geophysical Year forum can be seen when one considers the Washington Treaty Conference of 1959. Insofar as the United States was concerned, the IGY had dramatically allowed a change in the U.S. position with respect to Antarctica. It provided a comparatively long period (1955 to 1959) of widespread U.S. presence not dependent upon the efforts of a single explorer or upon military ventures. Scientific exploration brought in a clientele with a legitimate long-term interest plus regularized financial and management support through the National Science Foundation. The erosion of rights which had worried the normally nationalistic planners and policymakers since 1939 had stopped and the United States found itself in an advantageous position as the IGY came to an end.

Pursuing the efforts begun in 1947 to find an international solution for Antarctica, and encouraged by a parallel interest on the part of the British Commonwealth, the United States issued an invitation in 1958 to the IGY nations involved in Antarctica to meet in Washington in 1959 to negotiate a treaty for Antarctica.

The text of the note delivered on May 2, 1958, to the other IGY antarctic nations stressed heavily the progress which scientists had made in cooperation with one another in Antarctica. The last paragraph concluded:

> The International Geophysical Year comes to a close at the end of 1958. The need for coordinated scientific research in Antarctica, however, will continue for many more years into the future. Accordingly, it would appear desirable for those countries participating in the Antarctic program of the International Geophysical Year to reach agreement among themselves on a program to assure continuation of the fruitful scientific cooperation referred to above. Such an arrangement could have the additional advantage of preventing unnecessary and undesirable political rivalries in that Continent, the uneconomic expenditure of funds to defend individual national interests, and the recurrent possibility of international misunderstanding. It would appear that if harmonious agreement can be reached among the countries directly concerned in regard to

> friendly cooperation in Antarctica, there would be advantages not only to those countries but to all other countries as well.

At the same time, President Eisenhower released a statement which said:

> We do not want Antarctica to become an object of political conflict. Accordingly, the United States has invited eleven other countries, including the Soviet Union, to confer with us to seek an effective joint means of achieving this objective.
>
> We propose that Antarctica shall be open to all nations to conduct scientific or other peaceful activities there. We also propose that joint administrative arrangements be worked out to ensure the successful accomplishment of these and other peaceful purposes.
>
> The countries which have been invited to confer are those which have engaged in scientific activities in Antarctica over the past nine months in connection with the International Geophysical Year. I know of no instance in which international cooperation has been more successfully demonstrated. However, the International Geophysical Year terminates on December 31, 1958. Our proposal is directed at ensuring that this same kind of cooperation for the benefit of all mankind shall be perpetuated after that date.
>
> I am confident that our proposal will win the wholehearted support of the peoples of all the nations directly concerned, and indeed of all other peoples of the world.

It is interesting that in the note to other governments the United States implied that the IGY had been a regime. In the text of his remarks, President Eisenhower also enunciated the principal U.S. policy objectives in Antarctica.

Representatives of the twelve nations met in Washington on October 15, 1959, and after a month's work the Antarctic Treaty was signed, on December 1, 1959. The treaty provided that Antarctica be used for peaceful purposes only; that nuclear explosions and the dumping of nuclear wastes be prohibited; that open, unannounced inspections for conformity of activities with the provisions of the treaty be carried out. Furthermore, a formula was devised to place in abeyance for a period of time claims or rights

of the Antarctic Treaty nations, and to negate as a basis for future claims any activities conducted in Antarctica while the treaty was in force. The treaty furthermore made provision for representatives of governments to meet periodically to consult together on matters of mutual concern and to recommend to their governments measures in furtherance of the principles and purposes of the treaty. Such measures, when approved by all the governments, become part of the binding agreements under the treaty.

Perhaps some of the most significant and interesting parts of the Antarctic Treaty are those that deal with science. Article II of the treaty says:

> Freedom of scientific investigation in Antarctica and cooperation toward that end as applied during the International Geophysical Year shall continue subject to the provisions of the present Treaty.

It is interesting to reflect that the drafters of the treaty, with the experience of the International Geophysical Year freshly in mind, had a clear idea of what was meant by scientific investigation and cooperation toward that end as applied during the IGY. It meant, among other things, agreement on those critical issues of station locations, radio networks, and freedom of movement which had been settled in the international scientific planning forum for the International Geophysical Year. It meant patterns of cooperation and mutual assistance which had been practiced in the past several years by expeditions in Antarctica. One wonders whether new generations of antarctic scientists and politicians will find it useful to draft a new protocol to formalize for a broader area the established and accepted procedures of the scientific world.

Article III of the treaty gave the substance of working regulations to Article II by formalizing principles of the exchange of personnel, data, and results.

It is interesting finally to note that, to the limited extent to which the treaty deals with jurisdiction, it specifies that exchange scientists and other persons attached to expeditions will remain under the jurisdiction of their countries of origin. From this provision can be inferred the right of those involved in the scientific program to move about freely in Antarctica without fear of interference from jurisdictions centered on territorial claims. This freedom of movement applies to observers carrying out inspections in Antarctica.

The treaty is, therefore, a triumph for science, and since it came

into force in August, 1961, further steps have been taken under the consultative provision of the treaty to advance scientific interests. The arrangements for the exchange of scientific data among the signatory nations have been improved. Efforts are being made to regulate non-scientific activities, such as tourism, to produce the minimum interference with ongoing scientific programs.

Perhaps the most significant measures to be approved since the treaty has come into force are those dealing with conservation of living resources. These measures establish uniform practices to limit harmful interference to plant and animal life and to give special protection to ecological systems in selected areas of Antarctica against the careless inroads of human activities. Regulations have been implemented to prevent the introduction of exotic animals, plants, and diseases. Further measures are being considered to protect seals on the drifting pack ice surrounding Antarctica and to ensure that the relatively undisturbed environmental conditions of Antarctica are preserved for the benefit of mankind. It should be noted that this is probably the first time in history that steps have been taken in conservation before it is too late.

It is interesting to note that the Antarctic Treaty was the first of a number of important international measures which deal with the limitation of the use of nuclear explosions and with the regulation of human activities in areas other than the continents on which man normally lives—the Nuclear Nonproliferation Treaty and the Moon and Celestial Bodies Treaty, commonly known as the Space Treaty. Many articles of these latter agreements were drawn directly from the Antarctic Treaty.

The U.S. Government has made it a point to carry out cooperative scientific activities with the other treaty nations in Antarctica as part of the U.S. Antarctic Research Program. The most frequent of these is the exchange of scientists between expeditions. Last year, for example, U.S. exchange scientists joined the Japanese, United Kingdom, and the U.S.S.R. expeditions. Scientists from Belgium, Chile, Norway, South Africa, the Soviet Union, and the United Kingdom joined U.S. Antarctic Research Program field parties in Antarctica. These are cooperative programs in the sense that one nation extends its services and facilities to accommodate a scientist from another country.

There are, however, more involved programs of international cooperation. Last year (1969–1970), Argentina, Norway, and the United States continued for the third summer the exploration of

the Weddell Sea, utilizing icebreakers of Argentina and the United States, and underwater buoys supplied by Norway. In addition to logistic cooperation between the two icebreakers, scientists cooperated in the analysis and reduction of the data. As part of a long-term exchange of scientists between the Soviet Union and the United States, the United States has maintained a series of upper-atmosphere observations at the Soviet station, Vostok, at the geomagnetic south pole. The northern conjugate of this station, Kanak in Greenland, is operated cooperatively by Denmark and the United States. The results of this program, with the addition of other programs in Scandinavia, will be the subject of a joint publication by Danish, Finnish, Norwegian, Soviet, and U.S. scientists.

Four years ago, a U.S. scientist was invited by the French to join the rocket team at Dumont d'Urville, where he contributed significantly to the successful firing of three rockets during a major solar flare, a program in which he was able to contribute to the success not only in the field but in the subsequent analysis of results.

The United States two years ago provided the logistic support to a Norwegian field party of six which explored a heretofore unvisited mountain range in Queen Maud Land. This group represented the first return of Norwegian scientists to Antarctica since 1959; the United States was proud to have been able to assist the Norwegians in this effort, which was repeated again in the last antarctic summer (1969–1970).

The largest and longest program of cooperation in Antarctica is that between New Zealand and the United States. The United States uses New Zealand's facilities to mount our efforts in Antarctica and in return, under terms of a memorandum of agreement, New Zealand receives certain logistic support and assistance. Cooperation between New Zealand and the United States has gone beyond mutual logistic support and scientific collaboration. It has expanded into cooperation in establishing and administering Specially Protected Areas in Antarctica, and in the preparation of compatible regulations to govern activities of tourists at adjacent New Zealand and U.S. stations.

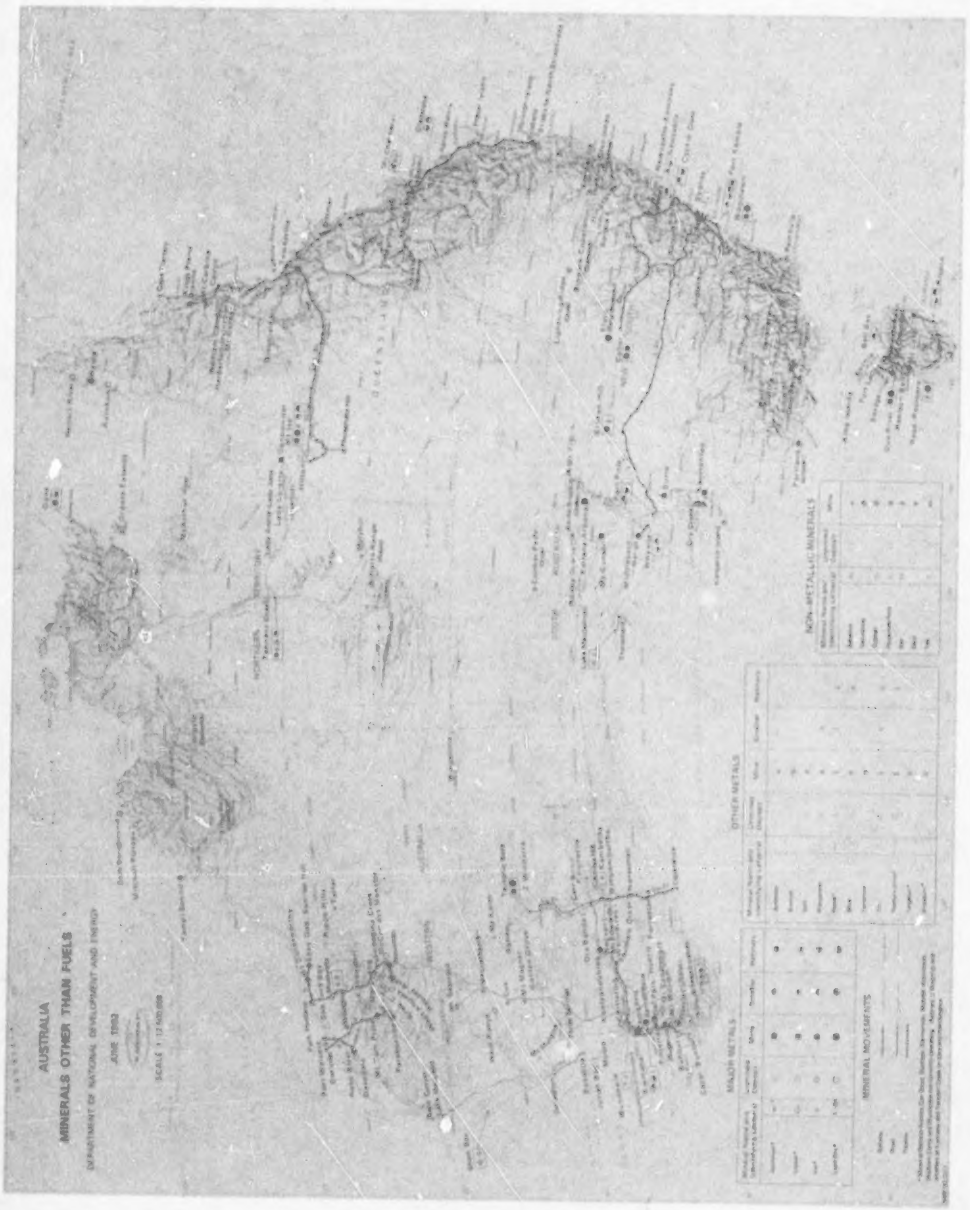
The history of the last sixteen years in Antarctica shows clearly that persistent and earnest cooperation can influence relationships among nations. We have seen that science can provide the grounds to initiate agreements which can circumvent causes of potential division and acrimony.

The history of Antarctica since the beginning of the International

Geophysical Year has been a story of the influence of science on national policy. Cooperation in international activities through national research programs has been shown not to spark aggressive national policies but rather to give vent to the national will to peace.

The success which has been achieved in Antarctica through the marriage of science and diplomacy should serve as a beacon for other areas. I do not mean to suggest that the precise way of operation or the agreements which have been entered into in Antarctica are directly applicable elsewhere. But good science pursued in its own international forums and conducted with an appreciation of the objectives and problems of international relations can serve to open routes for diplomacy. As science becomes increasingly concerned with the very big problems of man and his environment, the scientist must learn to accept responsibilities for the politics of his art, and the diplomat would do well to recognize that science is another avenue by which accord and agreement can be reached.

APPENDIX E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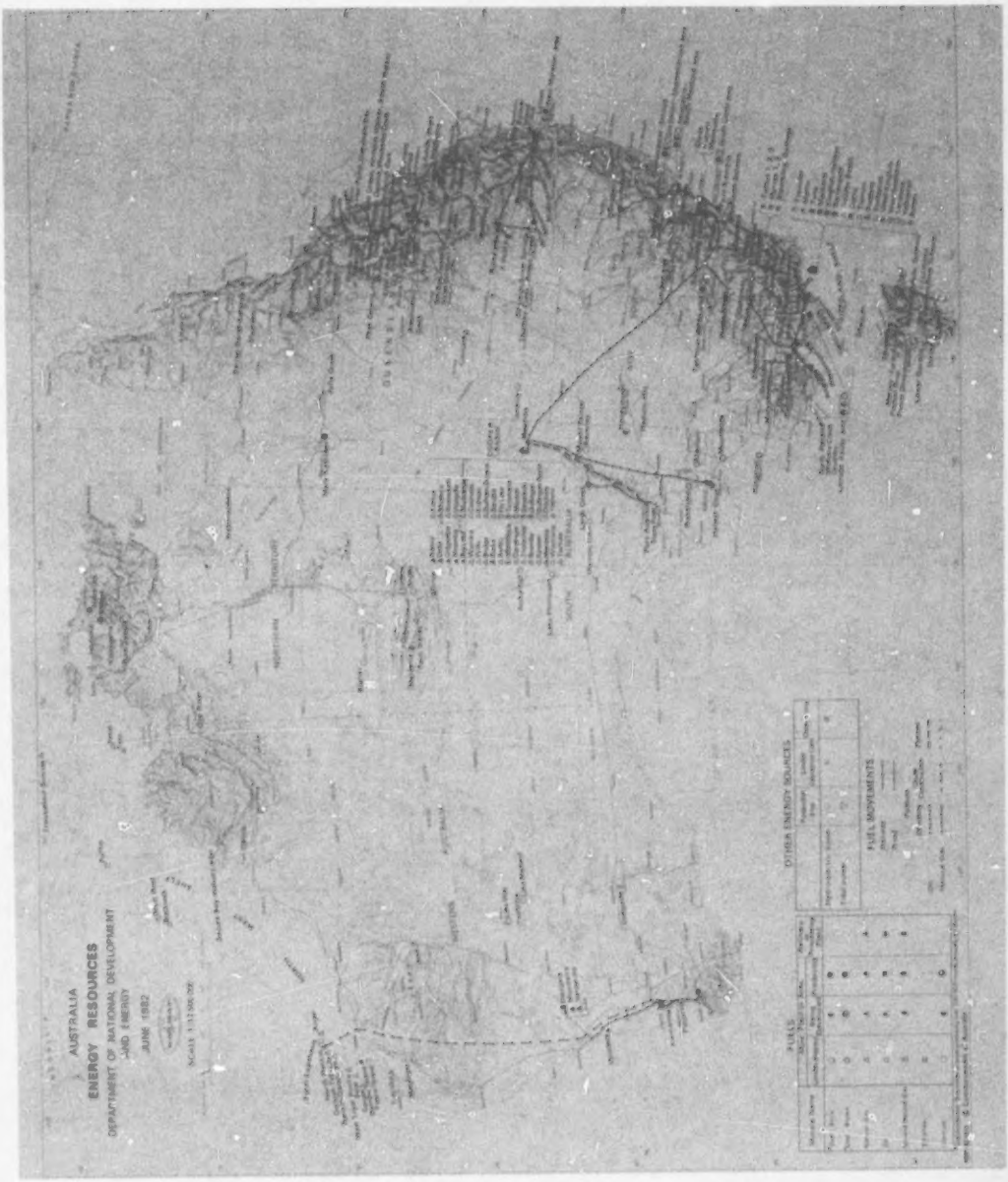
MINERAL MOVEMENTS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JUNE 1982
OTHER ENERGY SOURCES
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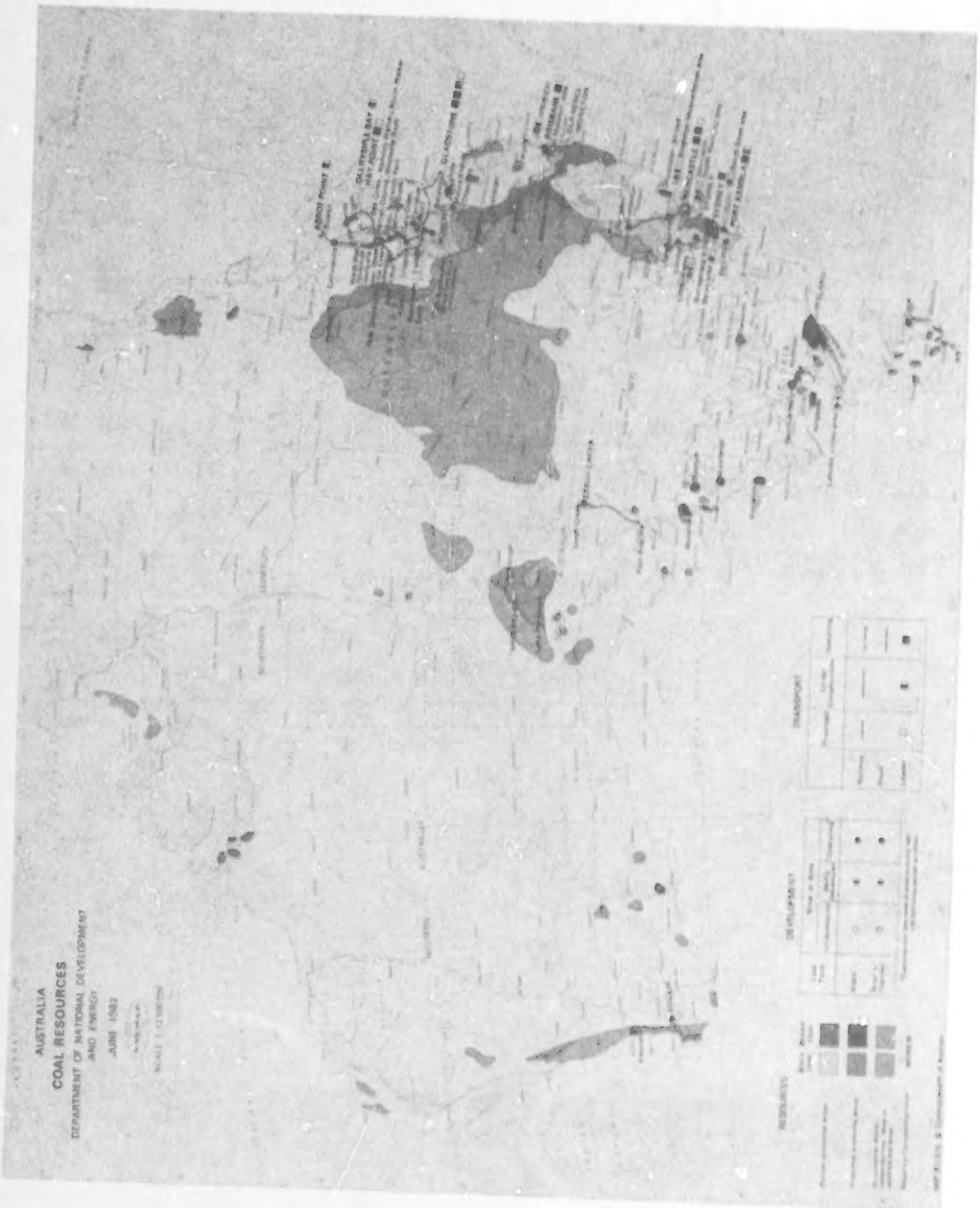
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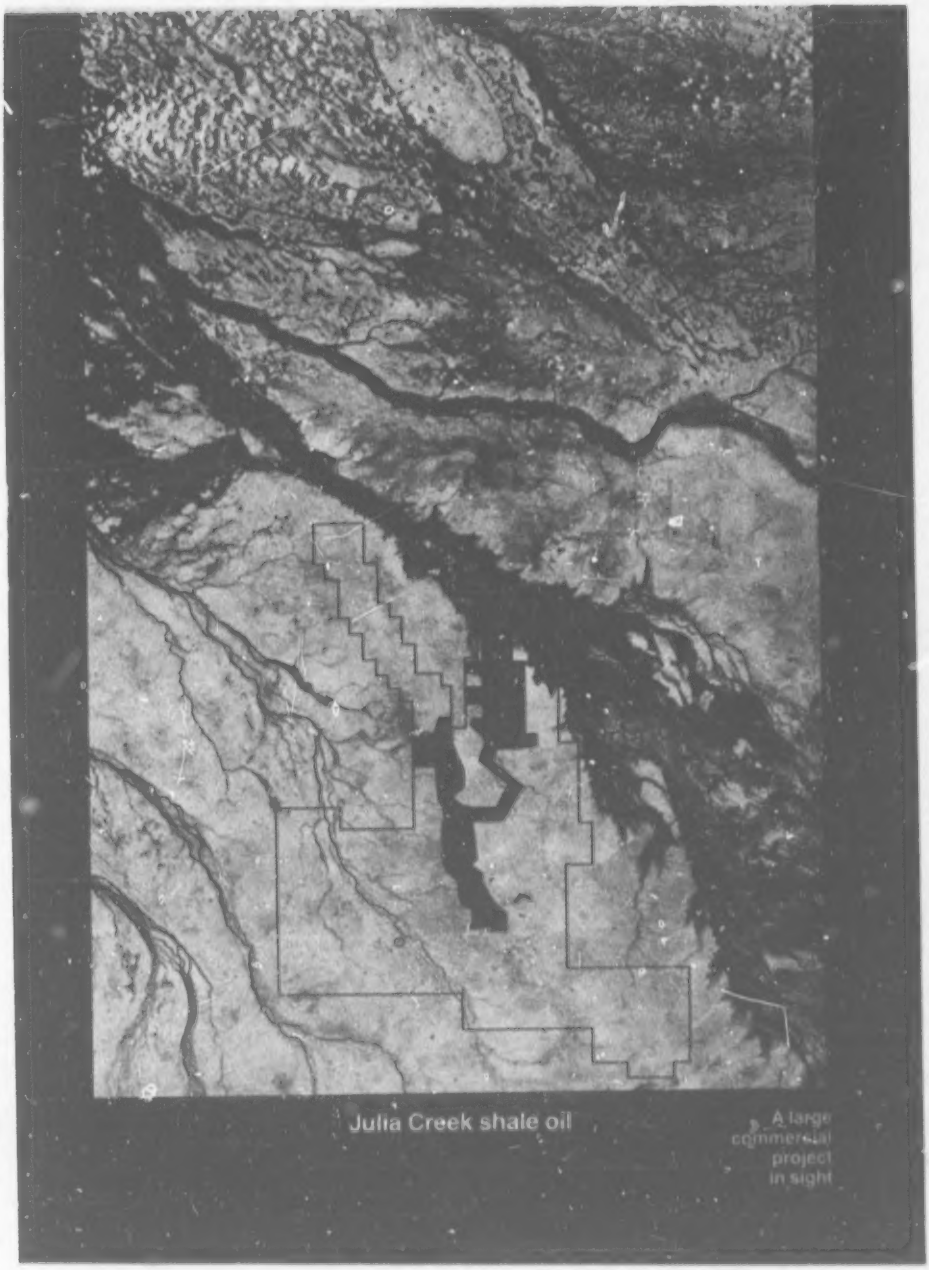

Julia Creek shale oil

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CSR is managed, staffed and predominantly owned by Australians. Its operations are based mainly in Australia, and international interests are expanding.

The company was founded as a sugar refiner in 1855.

Every year since it has made a profit and paid a dividend.

CSR ranks in the top five in Australia based on market capitalisation, and 190th on Fortune's 1981 list of the largest industrial corporations outside the USA.

Careful attention to diversity and balance of markets and end users gives the company a resilience to problems which may develop in any particular industry.

In recent years CSR has made a significant and successful diversification into Australia's energy supply industries.

The company is increasingly identified with the development of Australia's energy and mining resources.

CSR's ability to grow through 127 years of change is testimony to the way in which it conducts its affairs. The company contributes substantially to the economy of the communities in which it operates and to the wellbeing of the communities' citizens.

Cover:
This satellite photograph was taken when the Flinders River was in flood. The coloured area indicates CSR oil shale which could be mined by open-cut. The area is above flood level. CSR's Authorities to Prospect at Julia Creek cover about 2400 square kilometres.

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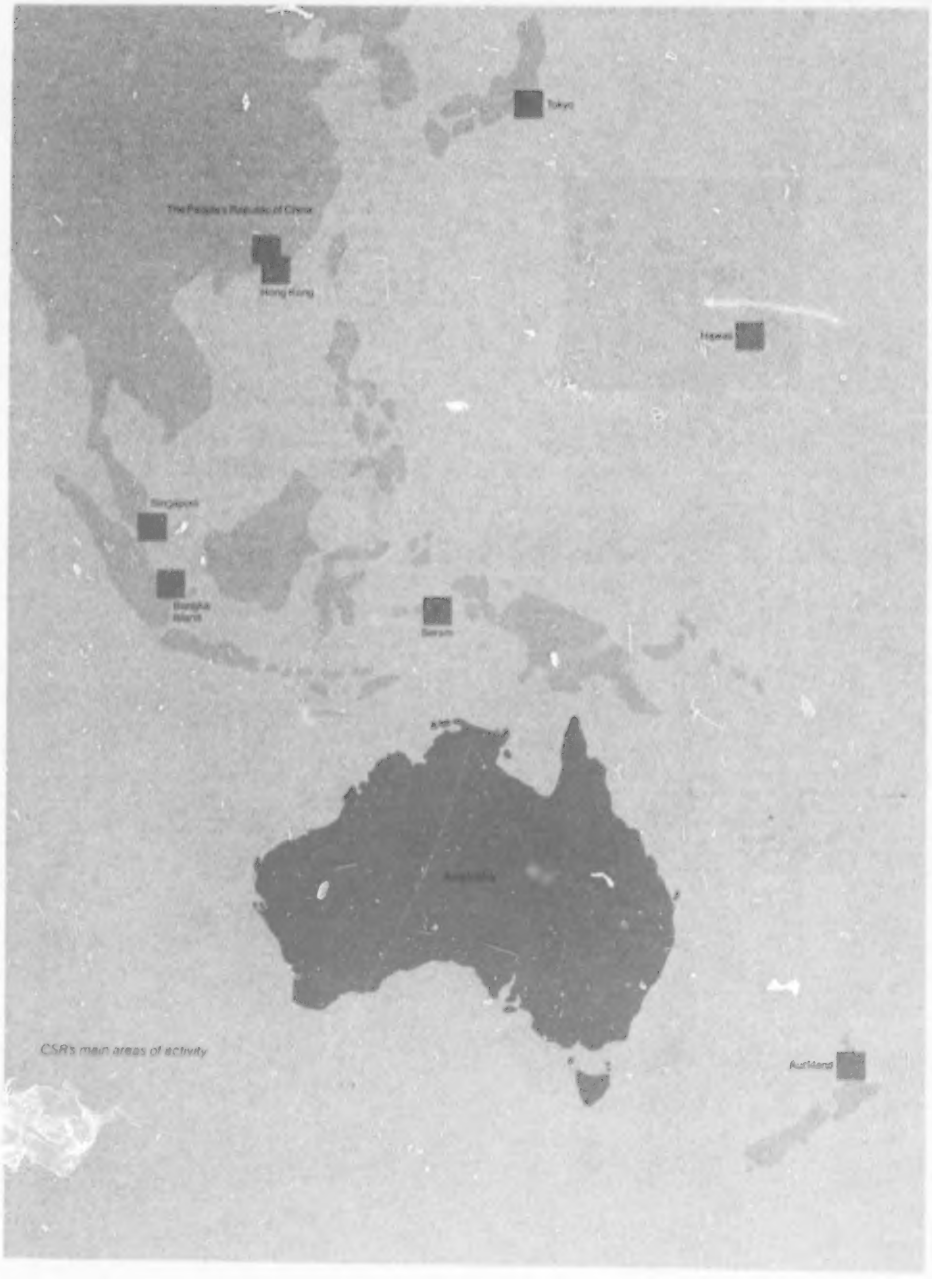

Tokyo
The People's Republic of China
Hong Kong
Hawaii
Singapore
Bangkok
Jakarta
Bangkok
Australia
Auckland
CSR's main areas of activity

Julia Creek shale oil project

CSR Limited has title to the best part of what is probably the biggest deposit of oil shale in the world.

The deposit, according to the Deputy Prime Minister and Minister for National Resources, Mr J D Anthony, contains sufficient oil to supply Australia's needs for about 12 000 years at a daily consumption rate of 650 000 barrels.

CSR has title to large areas of the deposit straddling the Townsville-Mount Isa railway and main road at Julia Creek. Very large quantities of shale are close to the surface and would be mined by open-cut methods. CSR's areas at Julia Creek are the best in the region.

For 13 years CSR has been investigating the commercial production of refined oil from Toolebuc shale. In 1980 CSR completed a preliminary feasibility study which showed that a large oil-from-shale plant at Julia Creek using tested technology would be close to economic at 1980 crude oil prices. It indicated that operations and infrastructure would not disrupt the environment although the project would be one of the largest mining operations in the world. The study also indicated areas of greatest economic sensitivity in the project.

Over the past two years CSR has concentrated on these sensitive areas and is developing new technology to:

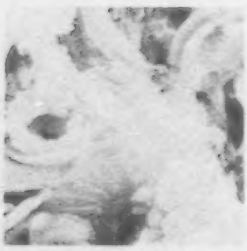
- reduce costs – capital and operating
- produce finished oil products of high quality that would command higher prices than those considered in the feasibility study
- increase output by recovering oil from deposits too deep to mine by open-cut.

In these studies CSR has been working with the Australian Government research establishment, the Commonwealth Scientific and Industrial Research Organisation (CSIRO).

The success of these studies has convinced CSR that the Julia Creek project may be close to economic at current world prices for oil, and that the studies should continue to further improve the project.

With viable economics in prospect and because project capital investment could be in the order of $6000 million CSR is seeking partners to contribute:

- first, on a low level to the cost of further preliminary work ($2 million over two years)
- then, on a larger scale, to a full feasibility study and the staged development of a demonstration project to produce between 500 and 5000 barrels of oil products per day to prove the technology
- later, to a commercial project to produce over 100 000 barrels of refined oil products per day over a period of at least 40 years, starting about 1995.



Toolebuc oil shale was formed in Cretaceous times from marine plant and animal life. The electron microscope photograph shows the remains of minute animals in the shale.

The Toolebuc oil shale formation is immense

The Toolebuc oil shale deposit, part of which CSR has been investigating since 1969, may, according to the Bureau of Mineral Resources, contain at least one million million barrels of recoverable oil – about three times the known reserves of the Middle East.

The deposit stretches southwards from the Gulf of Carpentaria to South Australia and New South Wales.

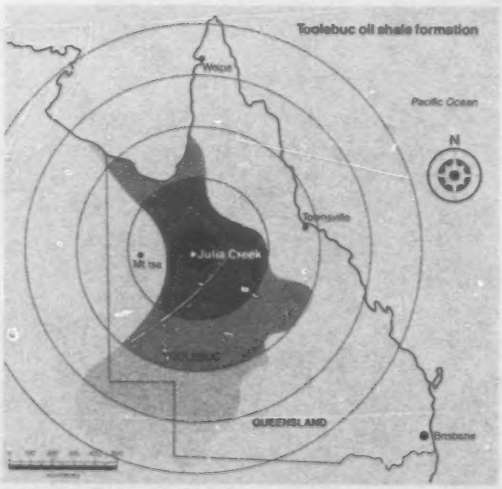
After drilling at about 1000 locations over a large area, CSR chose the Julia Creek area on the railway line between Townsville and Mount Isa as the most promising for oil shale mining.

The main title is for an area about 14 kilometres east of Julia Creek. This open-cut project has been closely appraised and is now known to contain sufficient oil to provide about one sixth of Australia's needs for at least 40 years.

Reserves of shale in this area contain about 1700 million barrels of oil, equivalent to about the oil reserves in Australia's largest oil producing area in Bass Strait. All the oil is recoverable. On average the shale yields about 70 litres per tonne and sufficient gas to refine the oil completely.

Nearby open-cut areas to which CSR has title are probably larger. They are now being drilled to determine additional reserves. Preliminary evaluation indicates a resource of up to 3000 million barrels of shale oil.

The mining area is flat, above flood level and offers no mining or environmental difficulties. The shale here is about 20 metres below the surface. Topsoil would be conserved for revegetation later. Overburden would be removed by bucket wheel excavators or draglines. Shale would be mined by blasting and face shovels.



The Toolebuc oil shale formation is the bed of an ancient sea. The best part for mining oil shale is near Julia Creek.

CSR's titles include deeper shale not far from Julia Creek. They contain about 10 000 million barrels of shale oil which could be recovered by a variety of techniques once commercial operations are established at Julia Creek.

Open-cut mining at Julia Creek would present few technical or environmental problems.

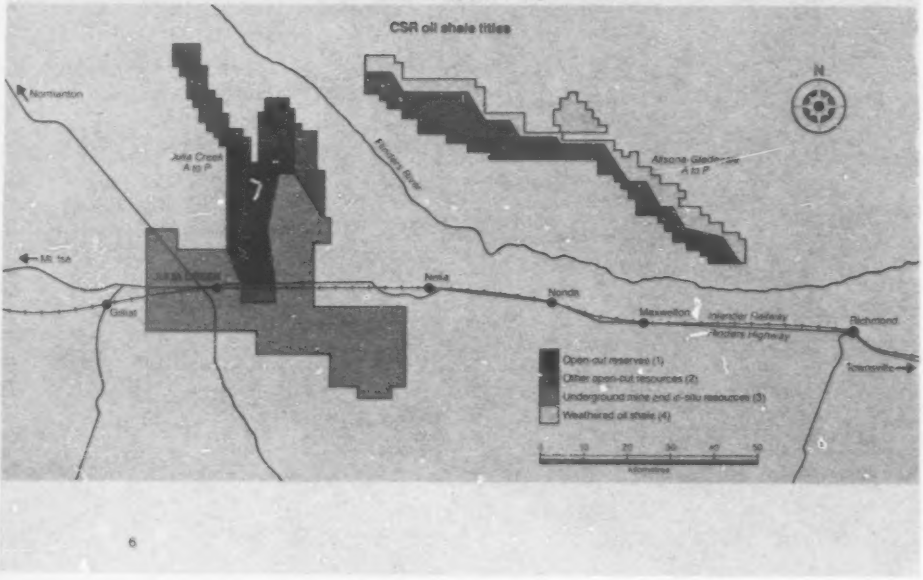
Mining would be a straightforward backfill operation using the largest available machinery. The ground is flat and the mine base firm. Overburden is expected to be stable before and after excavation. Mined-out areas, after return of overburden, topsoil and spent shale, levelling, compaction and revegetation are expected to be no more than 2 - 3 metres higher than the general area.

Neither flooding nor shale pollution problems are expected.

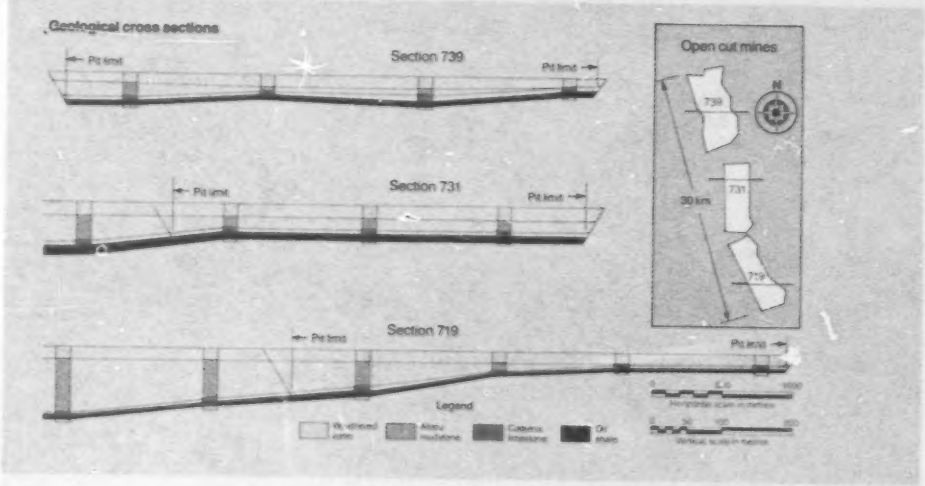
Output of about 100 000 barrels of oil per day would require three mines, each about 10 kilometres long.

The open-cut face would advance in a westerly direction at about 100 metres per year from an initial low wall in which overburden depth would be 20 – 25 metres.

CSR's oil shale titles straddle the Inlander Railway linking Townsville and Mount Isa. A sealed road follows the railway. The Authorities to Prospect (A to F) include (1) shale which would be mined by open-cut first (2) shale which would be mined by open-cut later (3) shale from which oil would be obtained by in-situ retorting or from underground mining.



Bucket wheel excavator of the type proposed for use in the Julia Creek project.



The market for shale oil products is assured

Australia produces about 66% of the crude oil it uses. It imports the balance (about 95 million barrels in 1980/81) from the Middle East and Indonesia.

Projections by Government and industry in Australia indicate that crude oil production will probably decline more rapidly than new oil can be discovered in Australia.

At the same time, oil consumption will rise.

Australia will increasingly depend on uncertain supplies of crude oil from overseas – unless a synthetic fuel industry is developed.

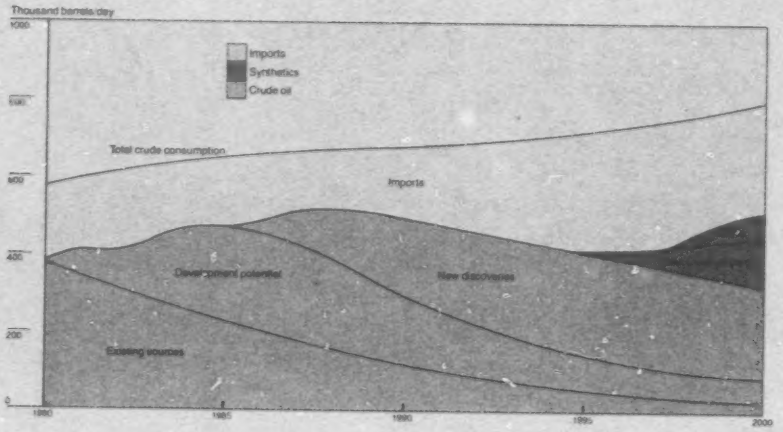
By the mid 1990s a commercial oil-from-shale plant at Julia Creek could produce about 100 000 barrels of oil products each day – about 15% of Australia's expected total demand.

The lead time is long because of the need to demonstrate technology before a commercial operation can begin.

At current crude oil prices, the Julia Creek project appears to be close to economic.

Australia's crude oil production could peak about 1988 and then begin to decline. Imports will make up the difference between domestic production and consumption. Julia Creek shale oil could replace about half estimated imports.

Forecast Australian oil supply and demand



Motor vehicles on register in Australia

At 30 June	Cars and station wagons ('000)	Com mercial vehicles ('000)	Motor cycles ('000)	Total vehicles ('000)	Increase over previous year: Cars and station wagons %	Commercial vehicles %	Motor cycles %	Total %
1950	784	506	134	1 484	17.4	10.8	14.0	14.6
1955	1 842	654	133	2 130	12.3	7.1	-6.4	8.4
1960	1 938	794	102	2 834	8.6	3.9	-6.8	6.8
1965	2 738	898	95	3 715	8.1	1.4	-8.1	6.2
1970	3 720	938	114	4 772	6.3	2.9	14.5	5.8
1975	4 859	1 140	278	6 277	5.5	4.5	7.4	5.4
1978	5 462	1 380	292	7 114	4.2	6.3	1.1	4.4
1979	5 657	1 413	288	7 388	2.6	3.9	-1.4	3.4
1980	5 799	1 464	311	7 574	2.5	3.6	8.0	2.9

Source: Australian Bureau of Statistics

New vehicles registered in Australia

Year	Cars and station wagons ('000)	Commercial vehicles ('000)	Motor cycles ('000)	Total ('000)
1960-61	223	59	8	291
1965-66	308	76	9	393
1967-68	347	76	21	444
1968-69	374	85	24	483
1969-70	408	90	27	526
1970-71	413	88	40	541
1971-72	413	89	51	553
1972-73	430	104	66	600
1973-74	485	108	85	679
1974-75	503	121	68	692
1975-76	455	130	80	665
1976-77	447	135	50	632
1977-78	432	131	38	602
1978-79	483	117	37	618
1979-80	452	118	54	622
1980-81	462	132	71	665

Source: Australian Bureau of Statistics

Persons per motor vehicle (Selected countries - beginning of year)

Country	1971: Based on cars	1971: On cars trucks & buses	1975: Based on cars	1975: On cars trucks & buses	1980: Based on cars	1980: On cars trucks & buses
USA	2.3	1.9	2.0	1.6	1.8	1.4
Canada	3.8	2.6	2.7	2.1	2.3	1.8
New Zealand	3.3	2.6	2.7	2.3	2.4	2.0
Australia	3.2	2.6	2.8	2.3	2.5	2.0
West Germany	4.2	3.9	3.8	3.3	2.7	2.5
France	4.1	3.5	3.5	3.0	2.9	2.5
Sweden	3.5	3.3	2.9	2.7	2.9	2.7
Italy	5.3	4.6	3.5	3.2	3.2	3.0
Netherlands	5.2	4.6	3.9	3.6	3.3	3.1
Japan	11.9	5.9	7.0	4.2	5.1	3.1
Britain	4.7	4.1	4.0	3.5	3.7	3.3
Venezuela	16.9	12.2	13.2	9.7	9.7	9.7
Greece	38.2	25.9	23.6	16.0	11.3	7.8
South Africa	14.0	11.1	12.6	9.1	12.2	8.8
Singapore	14.0	11.2	12.4	9.3	16.5	11.9
Brazil	41.8	28.4	22.6	16.9	14.6	11.7
Mexico	39.8	27.2	29.8	21.6	16.8	13.4
USSR	147.1	38.8	66.7	30.4	31.9	17.0

Sources: Automotive International/World Automotive Market; United Nations Monthly Bulletin of Statistics

Because of its size Australia is very dependent on transport fuels.

The Australian Institute of Petroleum forecasts that gasoline consumption in Australia will probably stabilise at present levels but diesel fuel and jet fuel consumption will continue to increase sharply.

Diesel fuel should increase from about 6000 megalitres in 1982 to between 9500 and 11 500 megalitres in 1990.

Jet fuel (aviation turbine fuel) should increase from about 2300 megalitres in 1982 to between 2500 and 2900 megalitres in 1990.

The operation and infrastructure will not disrupt the environment

Part of CSR's business philosophy is to be a "good corporate citizen, respecting changing community values and moving with the times to contribute to community objectives".

The Julia Creek project is in a remote part of Queensland. CSR owns many pastoral properties in the area, and has a good understanding of the region.

The present town has a population of about 1000 people, and facilities which support this population would have to be extended considerably to service the 16 000 people who would live in the new town.

Homes, other buildings and amenities would have to be provided for the town. Support facilities for the operation would include a 400 megawatt power station and a water reticulation system.

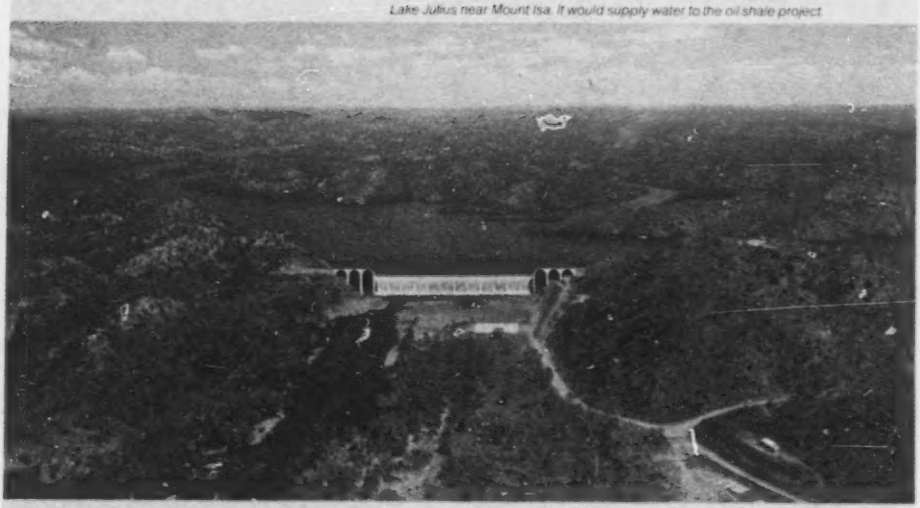
A minimum of 45 megalitres of water would be needed for the town, process plant and cooling.

Most of the water could be provided from an existing dam, Lake Julius, 200 kilometres west of Julia Creek. A supplementary source could come from a new dam on the Stawell River 200 kilometres east of Julia Creek. Artesian bore water, now running to waste, could be salvaged to provide seven megalitres per day.

All these aspects and others have been investigated to ensure that the project is self-supporting and self-reliant.

Allowances for their cost were built into the preliminary feasibility study carried out in 1980.

Lake Julius near Mount Isa. It would supply water to the oil shale project.



The environmental problems likely to be associated with the Julia Creek oil shale project have been examined. All appear to have ready solutions.

Work done on spent shale combustion shows that health hazards from silica in the shale would be eliminated by the formation of stable calcium silicates.

Other work done indicates that sulphur would not pollute the air at Julia Creek:

- sulphur in retort gas would be eliminated during retorting
- sulphur removed from shale oil could be disposed of during spent shale combustion; it could also be used for extracting vanadium from spent shale

The backfill open-cut mining operation envisaged would ensure safe disposal of combusted and spent shale by burying it under mined overburden. Topsoil would be returned and revegetation would occur after rain germinated native grasses.

The Julia Creek oil shale project will use water from Lake Julius, a proposed dam on the Stawell River and from uncontrolled Artesian bores which are now running to waste.

An Artesian bore with controlled flow. Many old bores are uncontrolled. Water from some of them could be salvaged.

A preliminary feasibility study after 10 years' work

The preliminary feasibility study which CSR produced was based on practical experience which started in 1969.

Part of the investigations of the Toolebuc oil shale deposit included the construction in CSR's research laboratories in Sydney of the only continuous pilot oil shale retort in Australia. It has been in use since 1970.

The retort can process about 0.5 tonnes of shale per day to provide information on shale retorting characteristics, product yields and oil samples for quality evaluation and refining trials.

In 1982 values, expenditure on the Julia Creek project is the equivalent of $15 million.

Work included:

- determining the extent, depth and thickness of the oil shale and its oil content
- pilot plant for oil shale retorting, spent shale combustion, product testing and by-product extraction
- economic evaluation and market investigations.

CSR believes the project is the most comprehensively studied and the most advanced of its type in Australia.

CSR completed a preliminary feasibility study (for a 100 000 to 115 000 barrel per day operation) in 1980. The study which cost $1.1 million was made over 19 months.

Main conclusions of that study were:

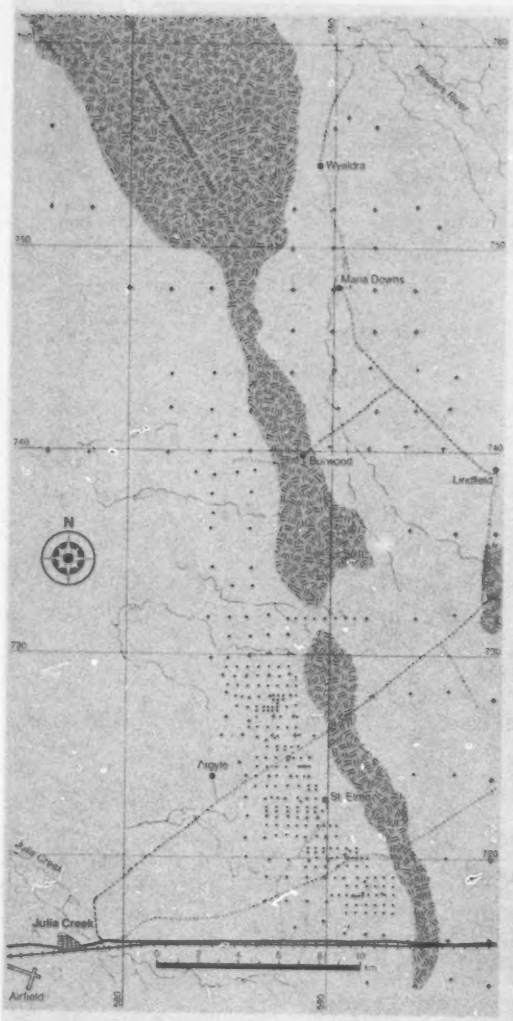
- about 115 000 barrels of refined (hydrotreated) shale oil could be produced each day for at least 35 years
- the project would include three large, open-cut mines, a number of retorts to extract oil from shale, a hydrotreater to upgrade the oil, a 1600 kilometre pipeline to Brisbane, a town for 16 000 people, water supply and other infrastructure
- capital cost would be about $5800 million, and the project would employ 5000 people
- for the project to generate an economic return –
  the Commonwealth Government's import parity pricing policy for oil would need to be maintained and
  the required price of Saudi Arabian light crude oil would need to be about $US42 per barrel fob.

At that time the profitability "gap" was $US10 per barrel. Since then advances have been made which appear to cover $US5-6 of that gap.

This improvement has arisen from:

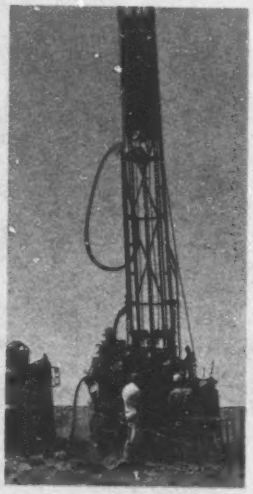
- higher quality product than assumed in the study
- advances in retorting process.

Documentation of the preliminary feasibility study completed in 1980. CSR did most of the work with help from consultants. The 19 month study cost $1.1 million. Subsequent developments of technology have improved the economics forecast in the study.



Part of the pattern of drilling which established the extent of shale which could be mined by open-cut near Julia Creek. More than 800 holes were drilled in the Julia Creek region. More holes have been drilled since this map was produced.

Light, mobile drilling equipment is adequate for resource appraisal drilling at Julia Creek. Core recovery is almost 100%.



Higher-value product and lower production costs

Significant changes have occurred since 1980 to improve the prospects of the project. The two most important are:

- the ability to make a high-value, final product instead of a lower-value, refinery feedstock
- improved technology which will reduce capital and operating costs.

As a result of these changes, the gap between the price of transport fuel and the required selling price of similar products from Julia Creek has narrowed to about $5 per barrel. The gap may close completely in a year or two.

The technology which has generated great optimism for the success of the project involves:

- a CSIRO-CSR retorting concept, which would reduce capital and operating costs, improve oil output and quality and reduce pollutants in retort effluents
- hydrotreating technology to upgrade the oil with hydrogen made from retort gas to produce a range of refined products
- in-situ retorting (producing oil without mining) trials conducted by CSR and ICI, the success of which would make available to the project vast amounts of oil that would otherwise remain in the ground.

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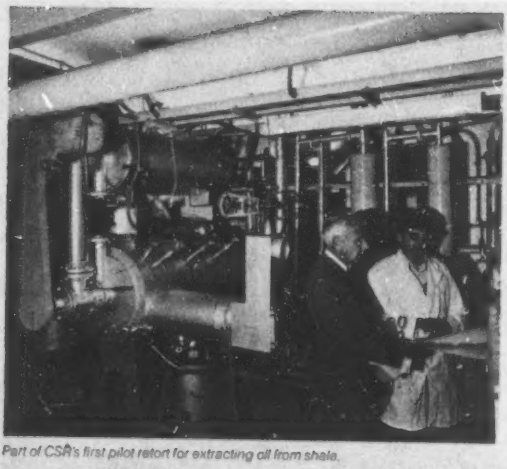


Part of CSR's first pilot retort for extracting oil from shale.

Oil shale from marine plant and animal life.

Retorting process breakthrough

Spent shale from the retorting process contains carbon residue. Pilot trials, with the CSIRO, showed that this material could be burned readily to provide the process energy required by the Julia Creek project. The discovery brings the proposed project closer to being commercial.

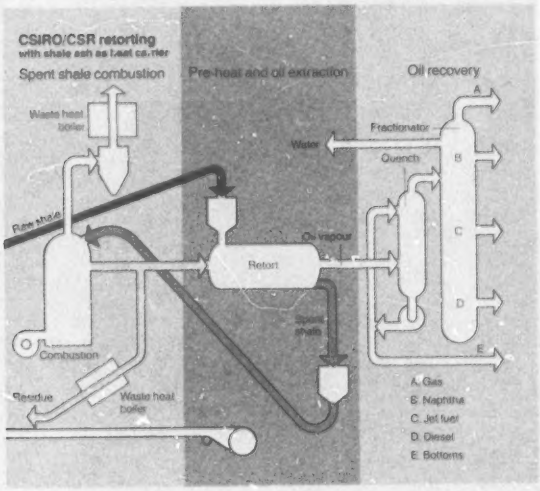
In the 1980 feasibility study, CSR assumed that extra raw shale would have to be mined to provide project heat, and that power would have to be purchased. However, the spent shale combustion trials have indicated that spent shale would be able to provide both project heat and power.

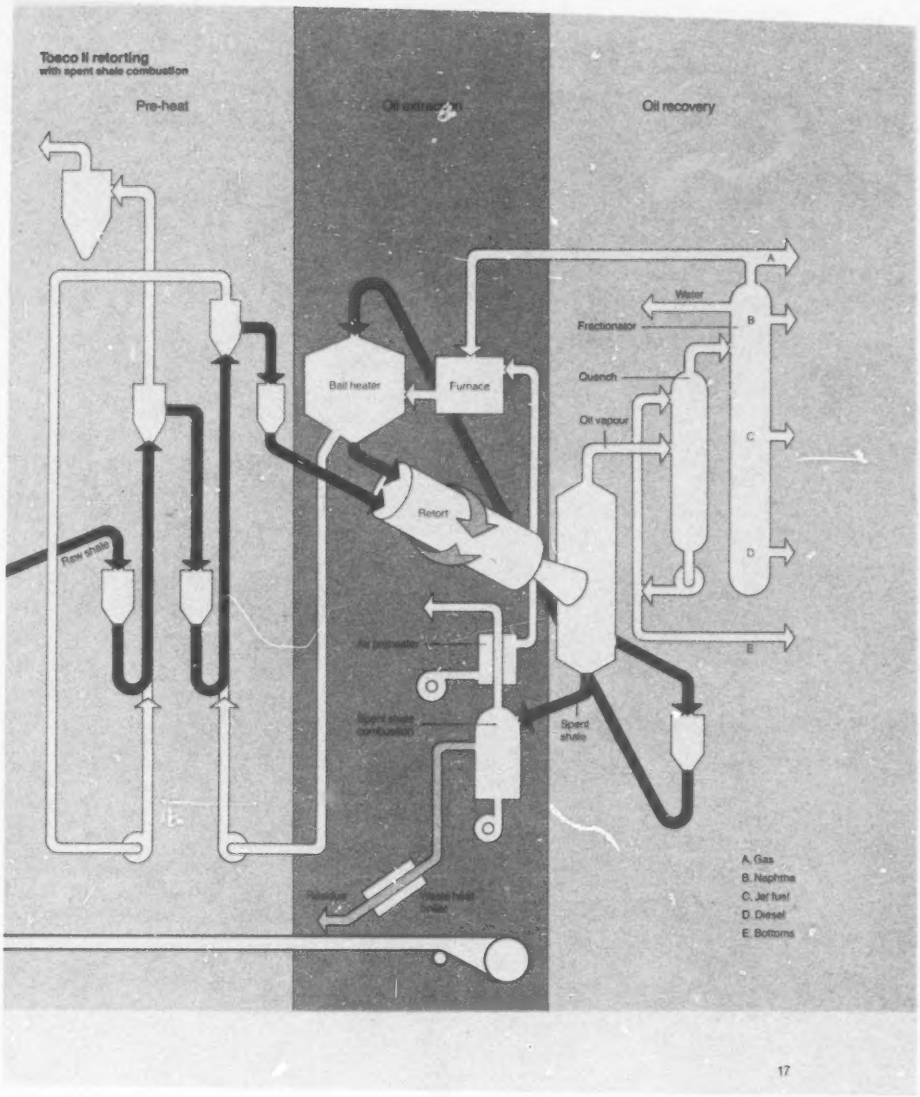
Following this development, CSR and CSIRO are collaborating to develop a new style of shale retort which would be fuel-sufficient, produce better quality oil and gas and eliminate waste water disposal.

The principle on which the retort is based has been patented. Final patent specifications have been lodged.

The new process bears promise of reducing production costs by up to $A4 per barrel.

The CSR pilot retort has been modified to investigate the CSR/CSIRO retorting technology. Results have been very promising.




Tosco II retorting
with spent shale combustion
Pre-heat
Oil extraction
Oil recovery
Water
Fractionator
Quench
Oil vapour
Ball heater
Furnace
Retort
Raw shale
Air preheater
Spent shale combustion
Spent shale
A
B
C
D
E
A. Gas
B. Naphtha
C. Jet fuel
D. Diesel
E. Bottoms
17

Hydrotreating would produce refined products

As produced from the retort, shale oil must be upgraded by increasing its hydrogen content.

The process, called hydrotreating, also eliminates sulphur, nitrogen and oxygen.

Hydrotreating is one of the keys to the success of the Julia Creek project because it would convert the crude oil into products such as gasoline, kerosene and diesel fuel. CSR has produced shale oil in its own pilot retort, and has hydrotreated the oil. The work indicated that market quality gasoline and other transport fuels can be made direct from Julia Creek shale oil.

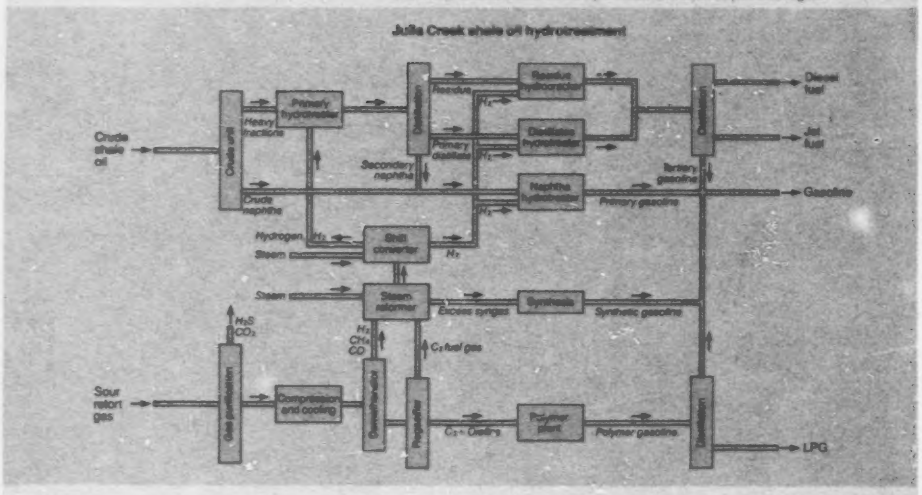
All the hydrogen required would be made from the gas from retorting the oil shale.

Studies so far indicate that a commercial project could produce about 50% gasoline, 15% kerosene and 35% diesel fuel. Already kerosene has been made to sulphur, nitrogen and aromatics* specifications. However, more work will be needed on diesel and gasoline fractions to meet product specifications, particularly their aromatics contents.

Work will also be needed to increase kerosene output for use as jet fuel and to make more diesel fuel and less gasoline.

*Aromatics are organic chemicals of the benzene family. In gasoline they increase octane rating but they are undesirable in kerosene and diesel fuel.

Julia Creek oil would be refined on site with hydrogen made from retort gas. The final products would be transport fuels and liquified petroleum gas.



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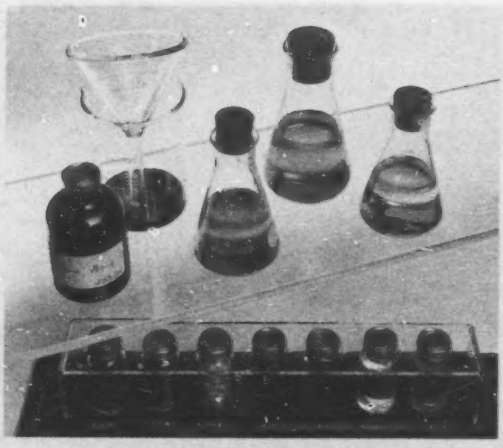
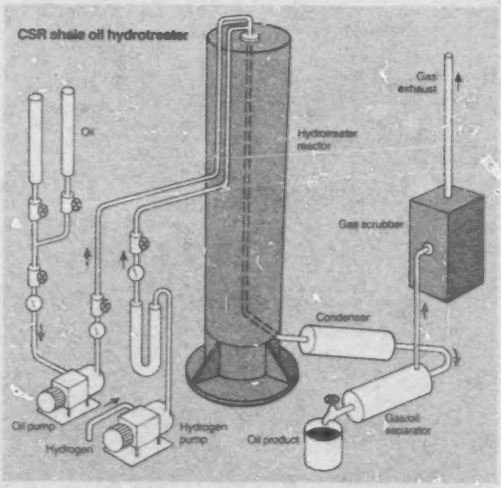


Crude and hydrotreated Julia Creek shale oil. CSR has produced kerosene, diesel fuel and naphtha fractions in hydrotreating trials.



Schematic of a new CSR pilot shale oil hydrotreater being built at its research centre in Sydney. Crude oil and hydrogen are pumped into the heated reactor which contains a catalyst. The hydrogen refines the oil in the presence of the catalyst. The oil is then cooled and separated from the exhaust gas.

Recovery of oil without mining

In 1981 retorting field trials at Julia Creek indicated the possibility of extracting oil and low heat value fuel gas from oil shale deposits which might not otherwise be used.

More development work will be required for the in-situ technology to recover oil from shale at depths of 80 metres or more.

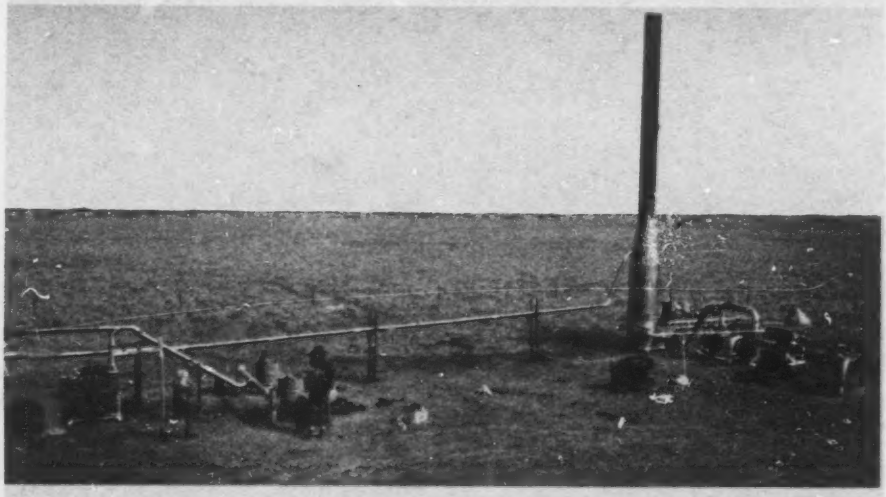
The aims of the trials to recover oil from shale by underground combustion were to:

- fracture the oil shale
- sustain underground combustion.

The important aspect of the trials was fracturing the oil shale to allow the passage of combustion air and the retort products.

CSR is optimistic about the technology. Given more development, a large source of oil could be tapped by underground retorting.

Oil can be recovered from the shale by using explosives to fracture the shale in-situ and then setting fire to it. Heat releases oil and gas which can be pumped to the surface.



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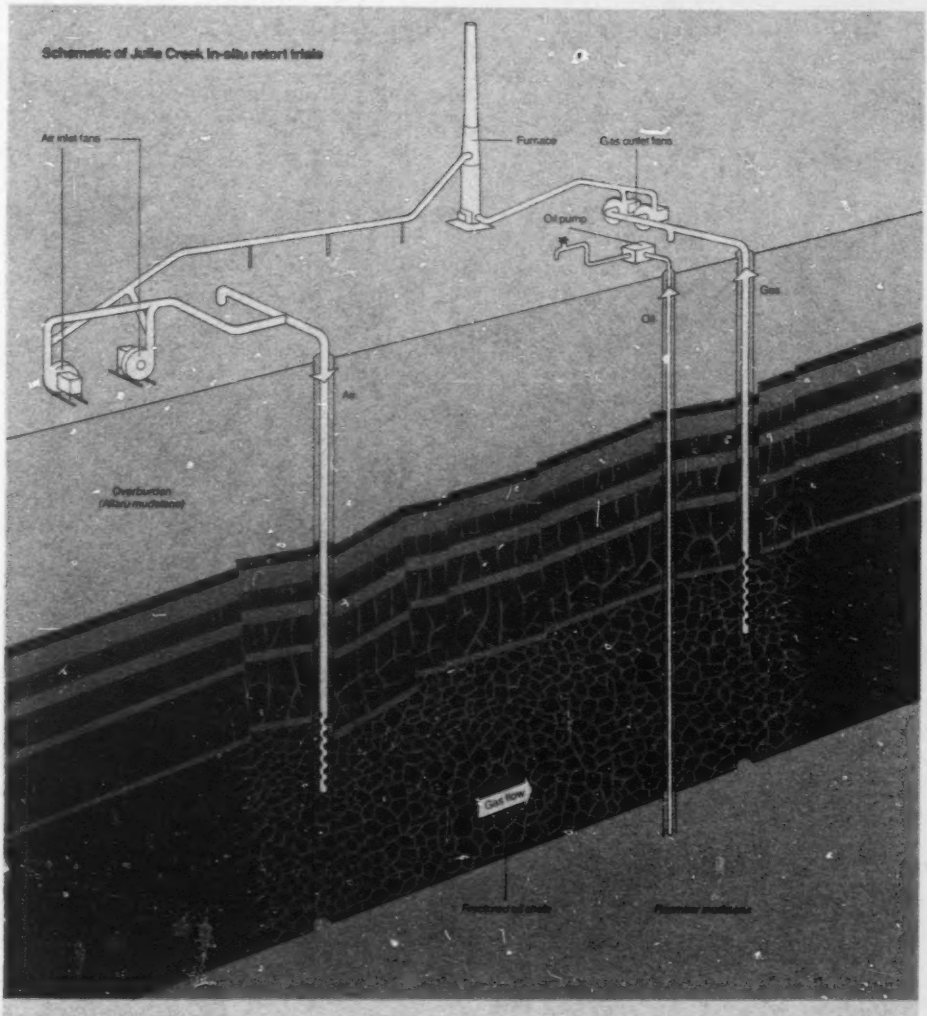

Schematic of Julia Creek in-situ retort trials
Air inlet fans
Furnace
Gas outlet fans
Oil pump
Gas
Oil
Air
Overburden
(Allaru mudstone)
Gas flow

21

Gradual lead-up to commercial stage considered most appropriate

CSR plans a gradual, staged approach to development. Heavy expenditure at first is not proposed.

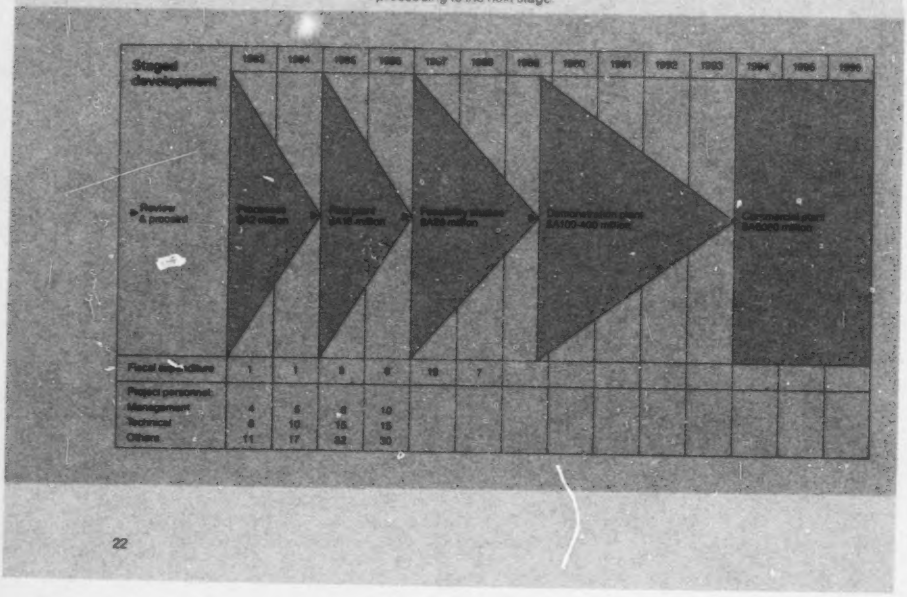
The initial process development plan would cost about $1 million per year.

CSR proposes that this expenditure be shared by a number of partners, who by so doing would earn rights to become investors in the full-scale commercial project.

As work progressed, and depending upon the results, increased expenditure could be required for:

- erection of a continuous pilot plant to retort shale (capacity 5 – 20 tonnes per day), produce oil and refine it on a continuous basis
- geological studies and a mine plan to produce between 0.5 – 4 million tonnes of shale per year, depending on retorting technology adopted
- feasibility study of a demonstration project to produce shale oil at rates between 500 and 5000 barrels per stream day, depending on the retorting technology adopted.

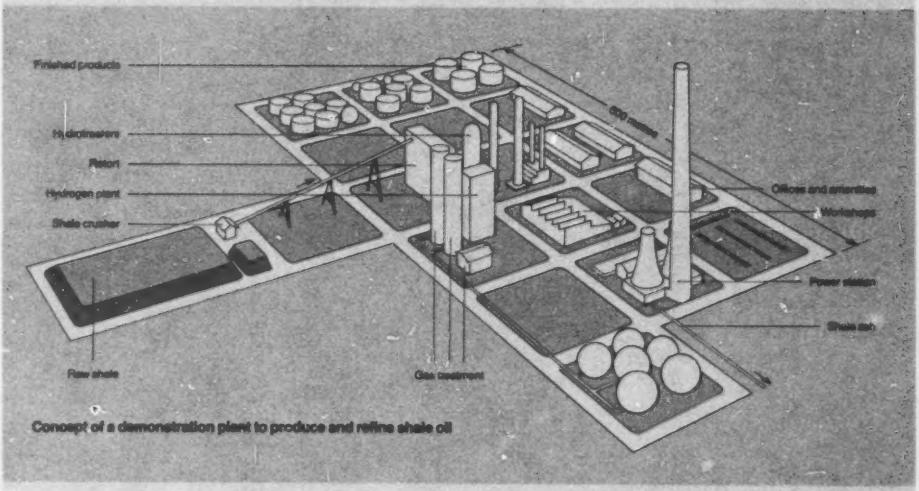
CSR plans development of the project in stages. Costs, low at first, would be shared between participants over about 10 years. The objective would be a feasibility study and a pilot project to demonstrate technology and economics. At the end of each of three stages, participants would review progress before proceeding to the next stage.



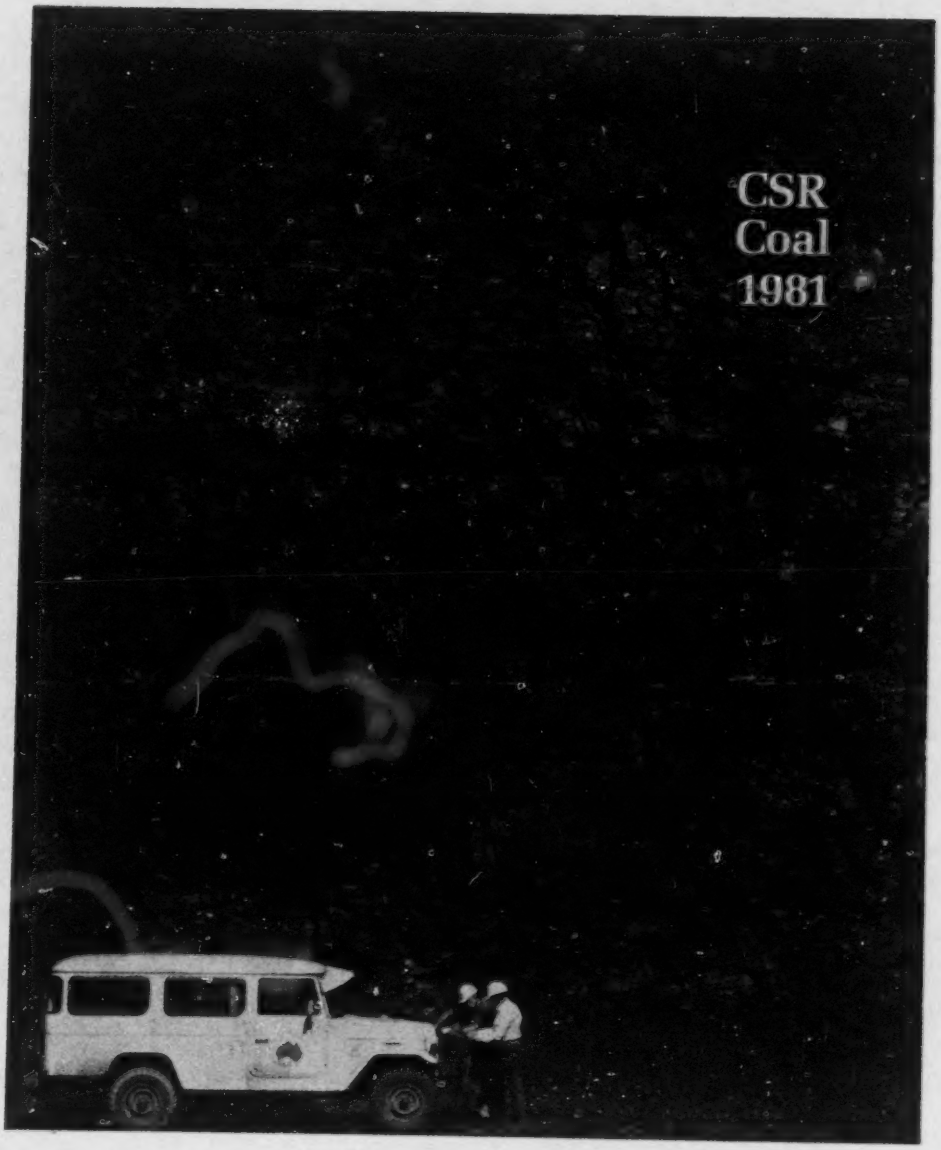
- feasibility study of a full-scale commercial project to be built about 1995.

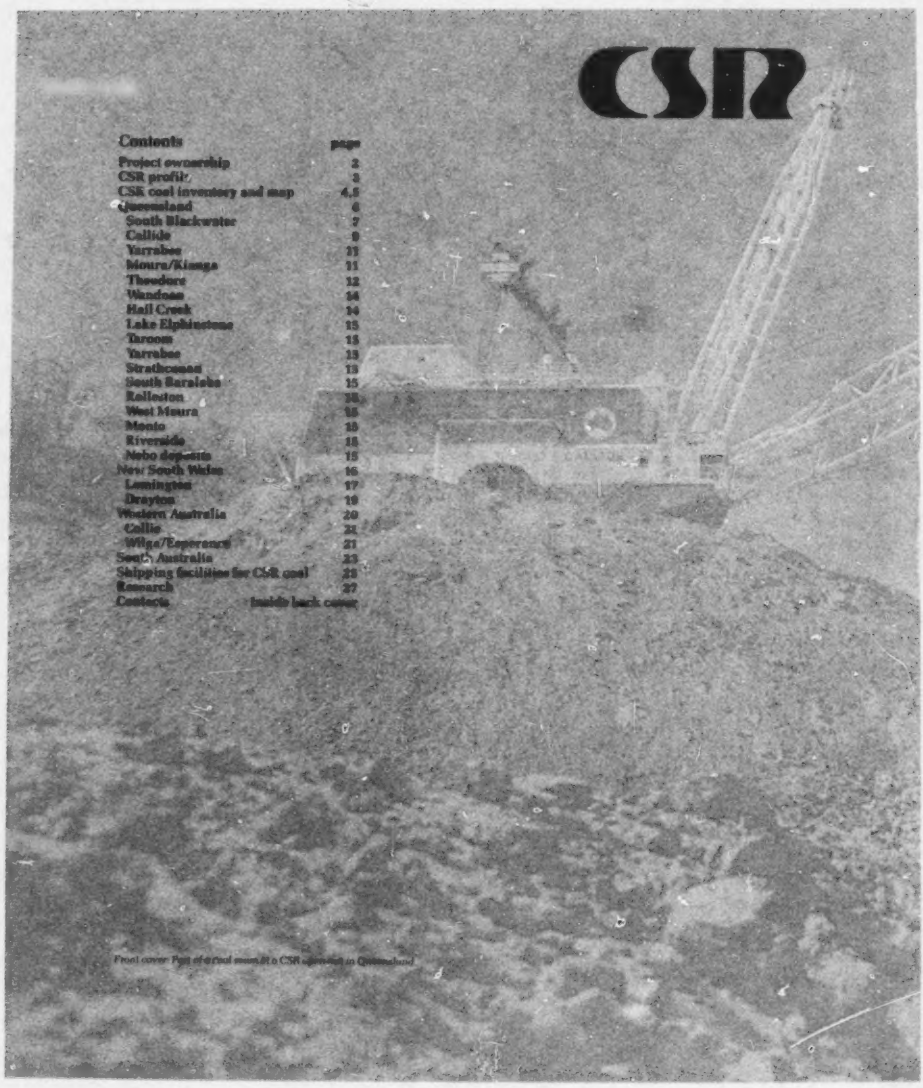
All that work would cost about $44 million, with each partner bearing a share over a minimum of seven years.

The work would lead to the establishment of a demonstration project, and finally to a commercial venture.



Concept of a demonstration plant to produce and refine shale oil


CSR
Coal
1981



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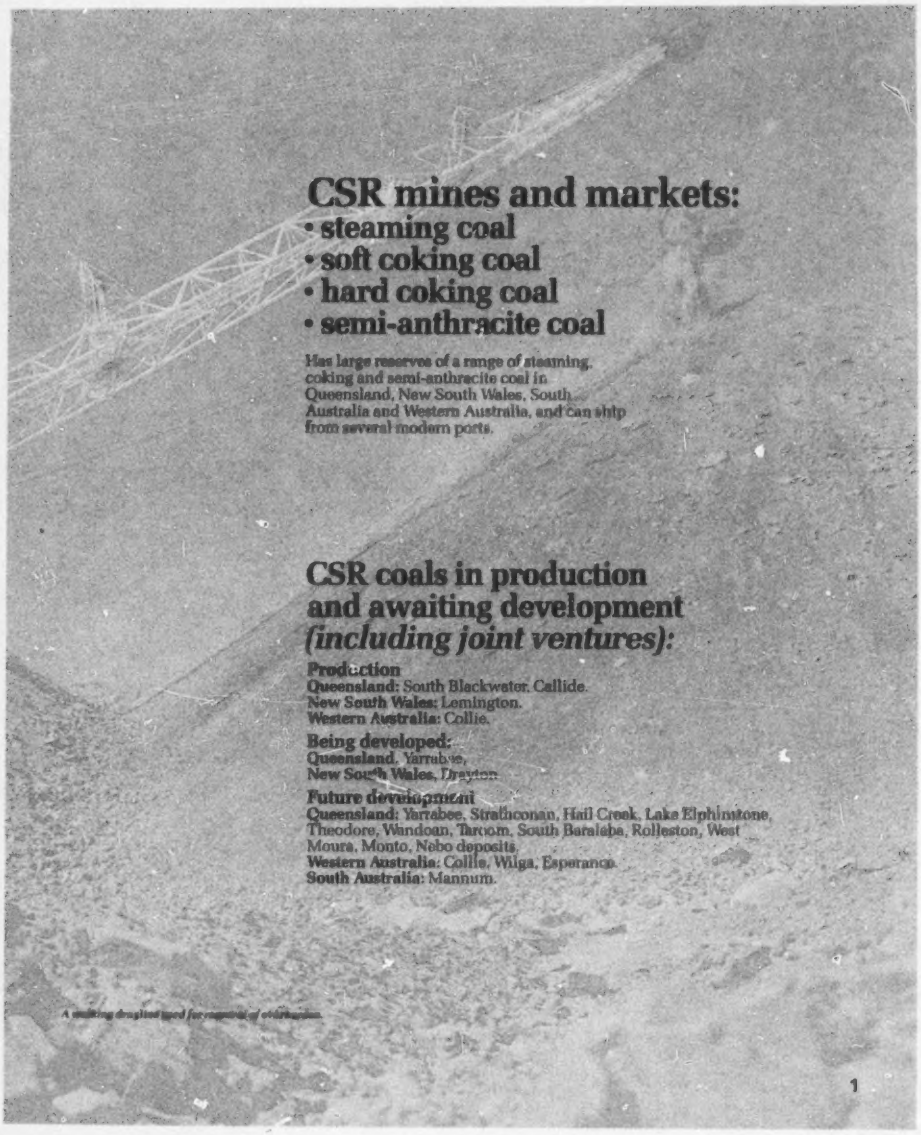
Front cover: Part of a coal seam at a CSR operation in Queensland


CSR mines and markets:
• steaming coal
• soft coking coal
• hard coking coal
• semi-anthracite coal
Has large reserves of a range of steaming, coking and semi-anthracite coal in Queensland, New South Wales, South Australia and Western Australia, and can ship from several modern ports.
CSR coals in production and awaiting development (including joint ventures):
Production
Queensland: South Blackwater, Callide.
New South Wales: Lemington.
Western Australia: Collie.
Being developed:
Queensland: Yarrabee,
New South Wales: Drayton.
Future development
Queensland: Yarrabee, Strathconan, Hail Creek, Lake Elphinstone, Theodore, Wandoan, Tarroom, South Baralaba, Rolleston, West Moura, Monto, Nebo deposits.
Western Australia: Collie, Wilga, Esperance.
South Australia: Mannum.
1

Ownership

Ownership of the projects mentioned in this booklet:			% CSR share
QUEENSLAND			
South Blackwater	—	Thiess Bros Pty Limited	100
Callide	—	Thiess Bros Pty Limited 55%, The Shell Company of Australia Limited 30%, Australian Mutual Provident Society 15%	55
Moura/Kianga	—	Thiess Dampier Mitsui Pty Ltd (Thiess Holdings Limited 22%, Dampier Mining Co Limited 58%, Mitsui & Co Limited 20%)	22
Yarrabee (a)	—	Thiess Bros Pty Limited	100
Yarrabee (b)	—	Brigalow Mines Pty Ltd (Thiess Holdings Limited 50%, MIM Holdings Limited 50%)	50
Strathcoman	—	Thiess Bros Pty Limited	100
Hail Creek/ Lake Elphinstone	—	CSR Limited 44%, Esso Exploration and Production Australia Inc 25%, IOL Petroleum Limited 25%, Marubeni Coal Pty Ltd 4%, Sumisho Coal Development Pty Ltd 2%	44
Theodore	—	Thiess Bros Pty Limited 60%, The Shell Company of Australia Limited 40%	60
Wandoan (a)	—	Brigalow Mines Pty Ltd (Thiess Holdings Limited 50%, MIM Holdings Limited 50%)	50
Wandoan (b)	—	Brigalow Mines/Rio Grande	40
Taroom	—	CSR Limited	100
South Baralaba	—	Brigalow Mines Pty Ltd (Thiess Holdings Limited 50%, MIM Holdings Limited 50%)	50
Rolleston	—	Brigalow Mines Pty Ltd (Thiess Holdings Limited 50%, MIM Holdings Limited 50%)	50
West Moura	—	Brigalow Mines Pty Ltd (Thiess Holdings Limited 50%, MIM Holdings Limited 50%)	50
Monto	—	Brigalow Mines Pty Ltd (Thiess Holdings Limited 50%, MIM Holdings Limited 50%)	50
Nebo deposits	—	Thiess Dampier Mitsui Pty Ltd (Thiess Holdings Limited 22%, Dampier Mining Co Limited 58%, Mitsui & Co Limited 20%)	22
NEW SOUTH WALES			
Lemington	—	Buchanan Borehol. Collieries Pty Ltd	100
Drayton	—	CSR Limited 44%, The Shell Company of Australia Limited 39%, Australian Mutual Provident Society 7%, Deesung Australia Pty Limited 2.5%, Hyundai Australia Pty Limited 2.5%, Mitsui Mining (Australia) Pty Ltd 3%, Mitsui Coal Development (Australia) Pty Limited 2%	44
Port Waratah Coal Services Limited	—	Buchanan Borehole Collieries Pty Ltd 25.5%, Gollin Loader Holdings Pty Ltd 19.5% (including 7.5% Thiess Bros Pty Limited), Coal & Allied Industries Ltd 12.5%, R W Miller and Co Pty Ltd 10%, Bloomfield Collieries Pty Ltd 2.5%, Toyo Menka Kaisha Ltd 10%, other Japanese trading companies 10%, Japanese coal consuming companies 10%	33
SOUTH AUSTRALIA			
Mannum	—	Thiess Bros Pty Limited	100
WESTERN AUSTRALIA			
Collie (a)	—	Western Collieries Ltd	100
Collie (b)	—	Western Collieries & Dampier Pty Ltd (Western Collieries Ltd 50%, Dampier Mining Co Limited 50%)	50
Wilga	—	Western Collieries Ltd	100
Esperance	—	Western Collieries Ltd	100

CSR – a large Australian coal company

CSR Limited is one of Australia's largest coal producers. In 1981 CSR and its subsidiaries expect to mine and market about 8 million tonnes of coal. It has a 22% interest in Thiess Dampier Mitsui Pty. Ltd. which expects to produce nearly 3 million tonnes in 1981.

CSR's Energy Division operates four large producing coal mines, and is developing or planning to develop several more.

In Queensland, the South Blackwater and Callide mines are operated by Thiess Bros., the Lemington mine in NSW by Buchanan Borehole Collieries, and the Collie mine in Western Australia by Western Collieries.

Expansion is planned for all four producing coal mines.

In addition to the deposits being worked, CSR has access to very large reserves of coal of various grades in deposits yet to be developed in eastern and Western Australia.

CSR coal includes soft and hard coking coal, steaming coal, semi-anthracite coal, and coal suitable for liquefaction.

About half the coal CSR now produces is used in Australia and about half is exported.

Lemington coking coal goes to Japan, Korea and Taiwan, and steaming coal to Europe, Japan and Hawaii.

South Blackwater coking coal goes to Japan, and steaming and briquetting coal to Japan, Taiwan and Korea. Other markets are being developed.

Callide and **Collie** steaming coal is used in Australia for power generation, cement manufacture and other industrial uses.

Yarrabee semi-anthracite coal will be exported to Japan in 1981.

Export of **Drayton** steaming coal to Japan, Korea and Europe is expected to commence by early 1983.

CSR has a 22% interest in the **Moura/Kianga** mines operated by Thiess Dampier Mitsui, which exports coking and steaming coal.

CSR export coal activities are linked by rail to well established, modern coal exporting ports: Gladstone in Queensland, and Newcastle in New South Wales.

The geographical spread of CSR coal reserves will enable it to offer coking and steaming coals from a number of ports on the east coast of Australia.

Deposits yet to be developed would ship through the coal port of Hay Point and Gladstone in Queensland, and Newcastle in New South Wales. Expansion of port facilities is planned.

The mines and deposits are also well served by modern towns, water supply, electricity, roads and airfields.

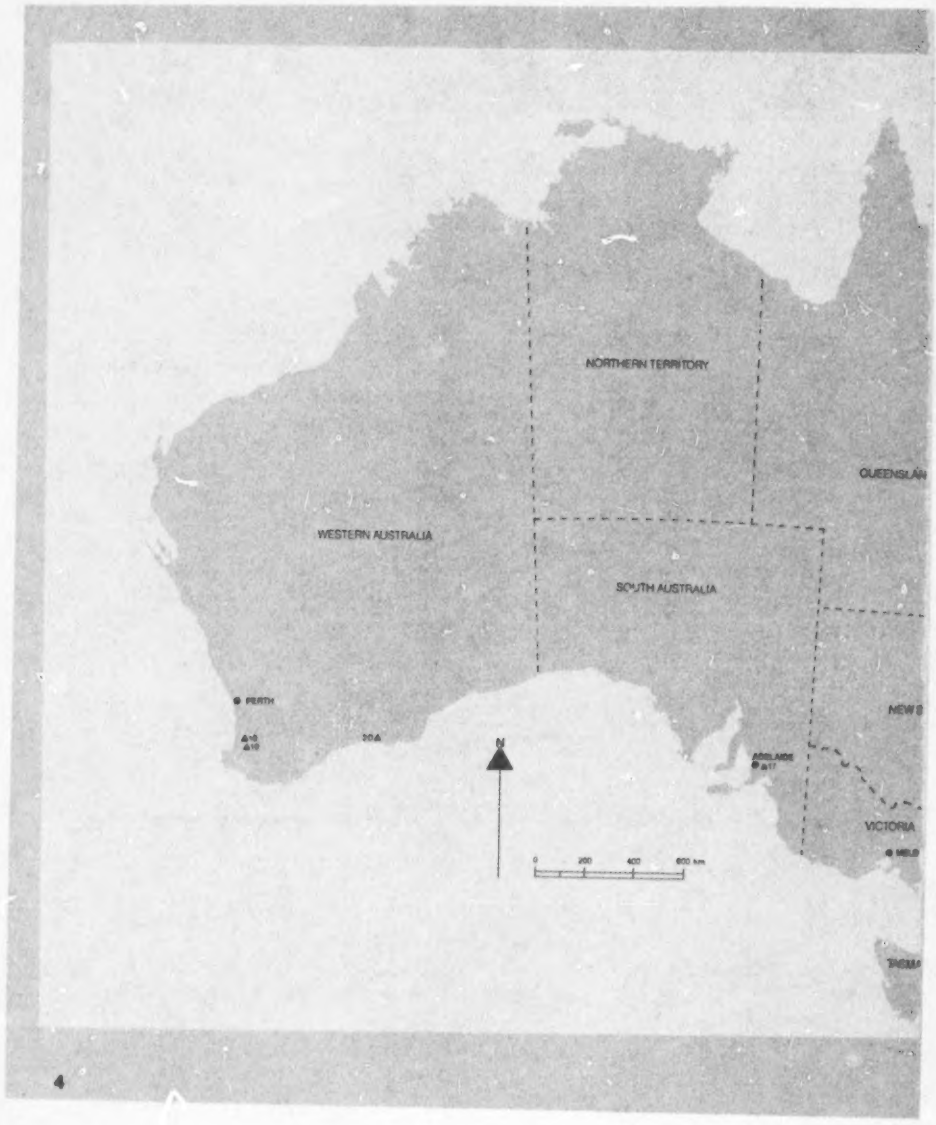
CSR continues to explore for coal, and conducts research into the use of coal. It is engaged in a feasibility study of coal liquefaction. The company has received several grants from the Australian Government for its coal and other energy-oriented research.

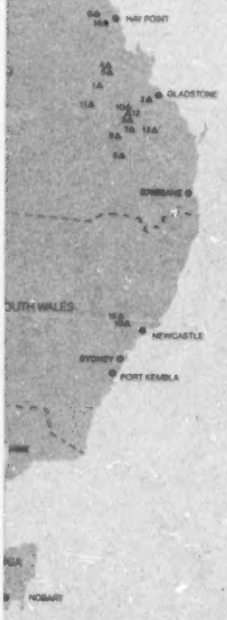
CSR Limited

CSR was established in 1855 and is one of Australia's largest companies; its main activities involve:

- coal, iron ore, bauxite, alumina, aluminium, copper, tin and gypsum
- oil and gas, and contract drilling for oil, gas and steam
- raw and refined sugar, molasses, industrial and potable alcohol, shipping
- industrial chemicals
- cattle and sheep properties, and macadamia nut orchards
- plaster, plasterboard, terracotta roof tiles, vinyl flooring, fibreglass and rockwool insulation, particleboard, hardboard, softboard, ceiling panels and rollformed metal
- pre-mixed concrete, asphalt paving, quarrying and cement
- civil engineering contracting
- port management
- exploring for coal, minerals and other raw materials
- conducting research and development.

CSR employs 15 500 people. The company is owned mainly by Australians, and is managed by Australians.


NORTHERN TERRITORY
QUEENSLAND
WESTERN AUSTRALIA
SOUTH AUSTRALIA
NEW S
VICTORIA
PERTH
ADELAIDE
MELB
TASMA
N
0
200
400
600 km



CSR coal inventory

	Type	Measured reserves	Indicated reserves	CSR's interest
		million tonnes		
In production				
Queensland				
(1) South Blackwater	coking/steaming	330	470	100%
(2) Callide	steaming	130	132	55%
(3) Moura/Kianga	coking/steaming	910	165	22%
New South Wales				
(15) Lemington	coking/steaming	220		100%
Western Australia				
(18) Collie (WCL)	steaming	233	224	100%
Awaiting development				
Queensland				
(4) Yarrabee	semi-anthracite	23	14	100%
Yarrabee (Brigalow)	semi-anthracite	16	16	50%
(5) Strathconan	semi-anthracite		18	100%
(6) Hail Creek	coking	158	582	44%
(6) Lake Elphinstone	coking	—	96	44%
(7) Theodore	steaming	628	612	60%
(8) Wandoan (a) (Brigalow)	steaming/conversion	309	249	50%
(8) Wandoan (b) (Brigalow Rio Grande)	steaming/conversion	307	181	40%
(9) Taroom	steaming/conversion	107	36	100%
(10) South Baralaba	semi-anthracite	—	—	30%
(11) Rolleston	steaming	274	148	50%
(12) West Moura	coking	—	364	50%
(13) Monto	steaming	—	—	50%
(14) Nebo deposits	coking/steaming	874	340	22%
New South Wales				
(16) Drayton	steaming	187	271	44%
South Australia				
(17) Mannum	steaming	58	154	100%
Western Australia				
(18) Collie (WCD)	steaming	70	20	50%
(19) Wilga	steaming	—	—	100%
(20) Esperance	steaming	—	—	100%

In Queensland
Mackay
Hay Point
Gladstone

CSR operates two mines, is developing a third, and has many other large deposits

CSR through a subsidiary, Thiess Bros Pty Limited (CSR 100%), mines coal at

- **South Blackwater** — open-cut and underground
- **Callide** — open-cut (Thiess 55%)
- **Yarrabee** — open-cut, is being developed to come into production in 1981.

Thiess also owns 22% of the Moura/Kianga mines.

South Blackwater

South Blackwater hard coking coal is produced from underground and open-cut mines. A recent $80 million expansion of the open-cut increased capacity of the field to 2 mtpy. The expansion program included:

- purchase of two Bucyrus Erie 1370 walking draglines with 43m³ buckets and a fleet of 120 tonne bottom dump coal hauling trucks
- modern stockpiling and handling facilities
- a large workshop.

All **South Blackwater** hard coking coal is exported to steel mills in Japan, but sales of briquetting and steaming coal have been made to Japan, Korea and Taiwan.

Thiess plans to increase production of steaming and coking coal.

Coal is mined from four seams.

The coal is washed in a dense medium coal preparation plant of 800 tph, and is sold as a washed, medium volatile, hard coking coal.

The briquetting coal is sold as a washed product and is suitable for form ed coke manufacture and blending.

Steaming coal with medium to low ash content, medium volatiles and high heating value is also exported.

Measured and indicated reserves are 800 million tonnes.

South Blackwater coal quality

Typical analysis	Coking	Briquetting	Steaming
Total moisture % (as received)	10	10	10
Inherent moisture % (air dried)	2	2	2
Volatile matter % (air dried)	27-29	22.5-24.0	23.3-25.0
Ash % (air dried)	7.5-7.6	6.0-6.5	10
Fixed carbon % (air dried)	63.3-63.2	67.5-63.5	62.7-61.0
Total sulphur % (air dried)	0.6	0.6	0.65
Chlorine % (air dried)	0.05	0.05	0.15
Nitrogen % (air dried)			1.75
CSN	5-7	1-1½	1-1½
Specific energy (MJ/kg) (air dried)	31.9	30	27.60
Calorific value (kcal/kg) (air dried)	7660	7170	6660
Hardgrove grindability	74	80	80
Vitrinite reflectance Ro (max.) %	1.05-1.1	1.05-1.1	
Maximum fluidity DDM	230	10	
Ash fusion temperature (reducing)			
initial deformation °C	1470-1560	+1200	+1200
Hemisphere °C	+1500	+1500	+1500
Flow °C	+1500	+1500	+1500

The modern coal reclaimer at South Blackwater. Steel fingers at the bottom of the reclaimer draw coal from the stockpile on to conveyors at the side.

The 42m³ bucket and part of the chain of the excavating dragline at South Blackwater opencast

Coal being loaded into 120 tonne trucks at Callide. Callide power station is supplied by road transport, Gladstone by railway.

Callide

Callide coal is used at an on-site power station to generate electricity for Central Queensland. In November 1980 the Queensland Government approved an expansion of the Callide power station by an additional 700 MW of generating capacity, requiring approximately 2 million tonnes of coal annually. Callide coal is also supplied to the Gladstone power station and other industrial users at Gladstone, including an alumina plant.

The mine is owned: Thiess 55%, The Shell Company of Australia Limited 30% and the Australian Mutual Provident Society 15%. Thiess Bros manage the project for the joint venturers.

Callide has about 270 million tonnes of steaming coal, of which about 225 million tonnes can be mined open-cut.

The coal seam ranges from 10 metres to 28 metres thick. This thick seam section also occurs in four other areas adjacent to the existing mine: Trap Gully, Boundary Hill, Oaky Creek and Kilburnie.

A $20 million expansion in 1978 included:

- a 33m³ Bucyrus Erie 1350W dragline
- new workshops
- a modern stockpiling and handling plant.

The expansion increased capacity to in excess of 2 mtpy.

Mining will be extended soon to Trap Gully. Boundary Hill will be developed to meet additional demand from 1983.

Callide coal has excellent characteristics for power generation and is also suitable for gas production.

Callide mine is 120 kilometres west of Gladstone and 20 kilometres from the town of Biloela.

Coal is railed to Gladstone over a heavy duty line built to carry export coking coal from the Thiess Dampier Mitsui Moura mine (Thiess 22%) which passes along the margin of the Callide coalfield.

Most mine employees live at Biloela, population about 6000. It is the main town of the Banana Shire in the agriculturally rich Callide Valley.

Callide coal quality

Typical analysis	Air dried	As received
Total moisture %		16
Inherent moisture %	9.4	
Volatile matter %	24.6	
Ash %	15.3	14.4
Fixed carbon %	50.1	45.4
Total sulphur %	0.22	0.20
Chlorine %	0.02	
Nitrogen %	1.3	
Ash	9	
Specific energy (MJ/kg)	28.1	25.0
Calorific value (kcal/kg)	6970	6200
Hardgrove grindability	60	
Ash fusion temperature (reducing)		
Initial deformation °C	+1500	
Hemisphere °C	+1500	
Flow °C	+1500	

View from the cabin of the walking dragline at Callide. Expansion to over 4 mtpy is planned.

15-550 O - 83 - 9

Yanahuara crane plant, and water supply dam and pipeline under construction.

Construction of a 37 kC tension steel wire which shall will be hauled from Yanahuara to the toll spur, Yanahuara and will then be rolled to Chiguisaca.

10

Yarrabee

Yarrabee coal ranges from semi-anthracite to anthracite. Several coal qualities can be produced. The deposit is owned by Thiess Bros Pty Limited. It contains 37 million tonnes, of which 23 million tonnes can be mined open-cut.

The deposit is 30 kilometres north of the township of Bluff and 300 kilometres from the port of Gladstone.

It is being developed to come into production in 1981 at a rate of 300 000 tpy. The coal will be shipped to Japan and other destinations through Auckland Point, Gladstone.

The semi-anthracite coal burns slowly, has 'high combustion' efficiency and low percentage of pollutants. The coal is suitable in the cement, carbide, lime, ferro-alloy and steel industries, and for home heating and steam raising.

Development and future expansion of the **Yarrabee** mine will provide a sound base for substantial exports of semi-anthracite coal from the region.

Yarrabee coal quality

Typical analysis

Total moisture % (as received)	9
Inherent moisture % (air dried)	2.5-3
Volatile matter % (air dried)	9-12
Ash % (air dried)	18-20
Fixed carbon % (air dried)	68-7a
Total sulphur % (air dried)	0.7
Nitrogen % (air)	1.6
CSN	0
Calorific value (kcal/kg) (air dried)	6200-7450
Hardgrove groveability	98
Ash fusion temperature (reducing)	
Initial deformation °C	1240
Hemisphere °C	1500
Flow °C	1580

Moura-Kianga

Thiess Dampier Mitsui (Thiess 23%) mine, at Moura/Kianga was the first large open-cut coal mine in Australia. The deposit was developed in 1960 to supply coking coal to japanese steel mills.

The mine produces coking and steaming coal, both of high quality. The Moura operation produces hard coking coal and Kianga soft coking coal. Capacity is about 4 mtpy.

It was the first in Australia to introduce large draglines for open-cut operations.

A Marion 8900 dragline was the largest in the world when introduced, and is still the largest in the Southern Hemisphere.

85 tonne coal truck.

The coal in Seam 6-7 exposed in the Theodore North trial mining pit. The seam is 5.5 metres thick and is covered by 20 metres of overburden. The seam is one of 21 seams in the Theodore coal field.

CSR has access to large undeveloped deposits of coal

CSR has access to large reserves of coal in undeveloped deposits in the coal fields of the

Dawson River Valley (**Theodore, Wandoan, Taroom, South Baralaba** and **West Moura**)

Central Highlands (**Yarrabee, Strathcoman** and **Rolleston**)

Mackay hinterland (**Hail Creek** and **Lake Elphinstone**)

In the Dawson River Valley, **Theodore** is suitable as a steaming coal and **Wandoan** and **Taroom** coals are suitable as steaming coals or for the production of oil. **South Baralaba** is a semi-anthracite and **West Moura** a prime hard coking coal.

The Dawson is one of Queensland's big rivers with a catchment of 50 000 square kilometres and an average annual flow of 240 000 megalitres. Sites for dams and more weirs have been selected in anticipation of a need for large quantities of water for industry and irrigation.

In the Central Highlands, large reserves of steaming coal are available at **Rolleston**, and semi-anthracite coal at **Yarrabee** and **Strathcoman**.

Hail Creek is a prime hard coking coal and is close to the export port of Hay Point near Mackay.

Theodore

Theodore is a large steaming coal deposit. Reserves extend for 50 kilometres along the valley of the Dawson River. The river crosses the deposit near the town of Theodore, dividing it into two areas — Theodore North and Theodore South. Both of these areas are suitable for open-cut mining. Theodore North is 230 kilometres by rail from the port of Gladstone.

The trial mining pit at Theodore North looking south along the strike. The low hills in the middle distance mark the base of the coal measures. The Theodore coal deposit extends 50 kilometres to the line of hills in the far background.

The workforce for the project will be housed at the town of Theodore which is conveniently situated between the proposed Theodore North and Theodore South open-cut mines. The Dawson River, shown here dammed up by the Theodore weir, will provide water for the project.

Reserves of 1240 million tonnes are contained in seams which range in thickness from 1.5 metres to 15 metres.

	North	South	Total
	(millions of tonnes)		
Measured	250	378	628
Indicated			
Class 1	253	359	612
Total reserves	503	737	1240
Suitable for open-cut	100	130	230

The Theodore coalfield is considered suitable for open-cut mining at levels of 9 million tonnes of coal per year; 4 million tonnes from Theodore North and 5 million tonnes from Theodore South. The mining method will utilise shovel and truck equipment.

The Theodore Project is a joint venture of Thiess Bros Pty Limited (60%) and The Shell Company of Australia Limited (40%). The manager of the project is the CSR subsidiary, Theodore Coal Pty Ltd.

Theodore Coal Pty Ltd is carrying out detailed investigations including:

- the development of the first open-cut mine located at Theodore North with a production capacity of 4 mtpy
- expansion of the town of Theodore to accommodate an expected work force of 900 people
- extending and upgrading the existing railway system between Theodore and the port of Gladstone
- the provision of water and power for the mine and town
- expansion by the Gladstone Harbour Board of the Clinton Estate coal facility to load 120 000 dwt vessels at a rate of 6000 tph.

Theodore is on the eastern side of the Bowen Basin, close to established infrastructure. Feasibility studies indicate that the project could deliver first coal in 1984. Firm sales arrangements would be required in 1981 to enable the joint venturers to begin shipments in 1984.

Following the commissioning of a mine at Theodore North, it is considered that a 5 mtpy open-cut mine could be progressively brought into production at Theodore South.

Theodore coal quality (in situ)

Typical analysis	North	South
Inherent moisture % (air dried)	4.5	6.9
Volatile matter % (air dried)	35.1	32.0
Ash % (air dried)	13.7	9.5
Fixed carbon % (air dried)	50.7	52.0
Total sulphur % (air dried)	0.8	0.6
Specific energy (kJ/kg) (air dried)	27 2	27 5
Calorific value (kcal/kg) (air dried)	6500	6560
CSN	1	½
Hardgrove grindability	56	53
Ash fusion temperature (reducing)		
Initial deformation °C	1380	1370
Softened °C	1390	1380
Hemisphere °C	1400	1390
Flow °C	1440	1400

Wandoan

Thiess Holdings Limited (CSR 100%) and MIM Holdings Limited each have a 50% interest, through their jointly owned (50/50) Brigalow Mines Pty Ltd, in the exploration and proposed development of the **Wandoan** coalfields.

Wandoan coal, deposited 150 million years ago, lies within the upper part of the Walloon Coal Measures of middle to late Jurassic age.

About 840 million tonnes of open-cut reserves have been outlined in the Wandoan area. Exploration began in 1973. Inferred reserves are large.

Ten large deposits have been found in an area adjacent to Wandoan township, and extending about 30 kilometres towards the west-north-west and south-east.

The largest of the deposits, Wolleebee, contains 252 million tonnes of shallow coal. An adjacent deposit, Austinvale, has 67 million tonnes of coal with an overburden-to-coal ratio of $2m^3$ per tonne.

Wandoan coal could be developed for:

- conversion to oil and gas
- on site electricity generation
- export steaming coal

As well as investigations being carried out by CSR, the coal is being tested for conversion by CSIRO, Australian Coal Industry Research Laboratories Limited (ACIRL), Imhausen (Germany), Exxon (USA), Mitsui (Japan), Idemitsu Kosan (Japan), Sumitomo (Japan) and Mitsubishi (Japan).

Processes being investigated include solvent refining, hydrogenation Fischer-Tropsch synthesis, flash pyrolysis, gasification and solvosis.

Exposure to a wide range of process technologies up to 1 tonne per day scale has indicated that **Wandoan** coal is one of the most suitable in the world for the production of oil.

Wandoan raw coal has good heating values, moderate ash, high ash fusion temperature and a very low pollutants content (sulphur, chlorine, nitrogen).

Wandoan has both the potential for domestic consumption and for the export of:

- washed coal with 10% to 12% ash and 26.0-26.5 MJ/kg specific energy
- products of a coal-based complex, including solvent refined coal, and synthetic crude products.

Features of **Wandoan** coal are:

- large reserves occur at shallow depths
- coal seams range up to 12 metres thick
- overburden-to-coal ratios average $3.5m^3$ per tonne for the field; large tonnages have ratios as small as $2m^3$ per tonne
- overburden is soft, consisting of thin veneers of sandstone and siltstone
- deposits are structurally undisturbed, and virtually devoid of ground water
- quality is consistently high throughout the field.

Mining feasibility and development plans have been prepared for the Austinvale and Frank Creek deposits based on reserves of 117 million tonnes of coal.

Thickness of coal seam and overburden, and the gentle topography, are ideal for strip mining with draglines. Shallow overburden and minimum dragline rehandle will assist rehabilitation of spoilpiles. Vegetation rehabilitation is planned to conform with environmental requirements of government authorities.

The township of Wandoan serves a fertile cattle and grain growing area about 350 kilometres from Brisbane and Gladstone. The township is well served by bitumen road, and is connected by rail to Brisbane.

Wandoan coal quality

Typical analysis	Raw	Washed
Total moisture % (as received)	11.9	12.0
Inherent moisture % (air dried)	8.9	7.9
Volatile matter % (air dried)	35.0	42.5
Ash % (air dried)	23.6	10.0
Fixed carbon % (air dried)	32.5	41.6
Specific energy (MJ/kg) (air dried)	21.3	28.2
Calorific value (kcal/kg) (air dried)	5100	6750
Total sulphur % (air dried)	0.32	0.38
Chlorine % (air dried)	0.04	0.03
Hardgrove grindability	41	31
Ash fusion temperature (reducing)		
Deformation °C	1350	1370
Hemisphere °C	1500	1510
Flow °C	1600	1560

Hail Creek

The Hail Creek Project, a joint venture, is owned by:

- CSR Limited 44%
- Esso Exploration and Production Australia Inc (a subsidiary of Exxon Corporation) 25%
- IOL Petroleum Limited (a subsidiary of CRA Limited) 25%
- Marubeni Coal Pty Ltd (a subsidiary of Marubeni Corporation) 4%
- Sumisho Coal Development Pty Ltd (a subsidiary of Sumitomo Corporation) 2%

Hail Creek Coal Pty Limited, a wholly-owned subsidiary of CSR, has been appointed manager for the project, and sales representative for each venturer.

The deposit, about 100 kilometres west of Hay Point, contains measured and indicated reserves of 740 million tonnes of raw coal from which a high grade, low volatile, low sulphur, hard coking coal could be produced. Of these reserves at least 150 million tonnes can be mined open-cut.

The joint venturers have completed feasibility studies, which, if long-term sales contracts can be finalised, would enable the project to be committed, with first shipment by April 1985. The development proposal includes:

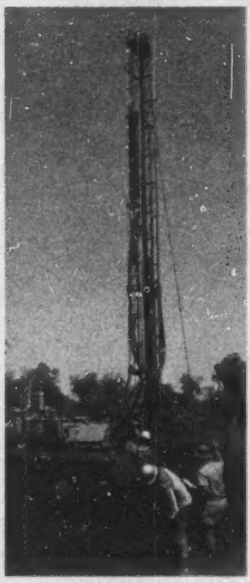
- a large open-cut mine using draglines, shovels and trucks to remove overburden and mine about 6.5 million tonnes of raw coal per year
- production of 3.5 million tonnes in the first year and then 4.5 million tonnes per year of product coal from a 1500 tph coal preparation plant at the mine
- provision of maintenance support, amenities, administration and other facilities at the mine
- a new town about 8 km from the mine to house about 3000 people
- provision of a fresh water supply based on an extensive underground aquifer at Braeside, 67 kilometres from the mine; this will be later supplemented by water from a dam to be built on Denison Creek about 56 kilometres from the mine
- building of 60 kilometres of rail line from the mine to join the existing rail line at Waitara 100 kilometres from Hay Point; part of the line from Waitara to Hay Point would be upgraded
- building of a coal storage and loading installation at Hay Point; the off-shore facility to be financed and constructed by the Queensland Government and capable of loading vessels up to 150 000 tonnes at a rate of 6000 tph.

Hail Creek coal quality

Typical analysis	
Total moisture % (as received)	10.0
Inherent moisture % (air dried)	1.0
Volatile matter % (air dried)	19.9
Ash % (air dried)	10.5
Fixed carbon % (air dried)	68.6
Total sulphur % (air dried)	0.4
CSN	6-7
Hardgrove grindability	90
Vitrinite reflectance Ro (max) %	1.3
Maximum fluidity DDM	60

Lake Elphinstone

The Lake Elphinstone deposit, adjacent to Hail Creek, contains 98 million tonnes of raw coal, from which a medium volatile coking coal could be produced.



Proving reserves of coal at Taroom.

Taroom

The Taroom deposit contains about 143 million tonnes of steaming coal: very high volatile, bituminous coal. The deposit is 10 kilometres south of the town of Taroom. It is part of the Jurassic Period Walloon Coal Measures, occurring in the Taroom trough in the northern part of the Surat Basin.

Drilling has proved reserves suitable for open-cut mining; 155 bore holes totalling 8557 metres have been drilled. Nearest railheads are Theodore, 90 kilometres north, and Wandoan, 47 kilometres south. Taroom is owned by CSR Limited.

Taroom coal quality

Typical analysis	
Total moisture %	13
Inherent moisture % (air dried)	2.6
Volatile matter % (air dried)	37.4
Ash % (air dried)	23.6
Fixed carbon % (air dried)	35.4
Total sulphur % (air dried)	0.7
Chlorine % (air dried)	0.01
Nitrogen % (air dried)	0.96
Specific energy (MJ/kg) (air dried)	22.2
Calorific value (kcal/kg) (air dried)	5300
Hardgrove grindability	40
Ash fusion temperature (reducing)	
Initial deformation °C	1540
Hemisphere °C	+1550
Flow °C	+1550

Yarrabee

Semi-anthracite coal areas controlled by Brigalow Mines (Thiess and MIM 50/50 joint venture) and Thiess have reserves of 69 million tonnes of coal with a maximum seam thickness of 10 metres.

The Brigalow Mines semi-anthracite deposit is also known as **Yarrabee**. The second Thiess deposit is known as **Strathcoaan**.

South Baralaba

Brigalow Mines Pty Ltd (Thiess-MIM) is investigating semi-anthracite coal in the northern part of the West Moura tenement near Baralaba township. Exploration has established several seams at relatively shallow depths.

South Baralaba is 235 kilometres from Gladstone by rail.

Inferred reserves to 60 metres depth are 20 million tonnes, of which 5 million are regarded as mineable.

Rolleston

Rolleston, a Brigalow Mines deposit (Thiess-MIM) has 422 million tonnes of steaming coal, of which about 185 million tonnes could be mined open-cut.

The coal occurs in three seams which range in thickness up to five metres.

With low ash, high volatile matter, high specific energy values and low sulphur and mineral contents, the coal is well suited for power generation and for the production of synthetic fuels.

Export of the coal through Gladstone would require the construction of a coal transport system from the mine to the railway at either Blackwater or Moura.

Coal transport by slurry pipeline system is being investigated as an alternative. A possible route for such a pipeline is through Theodore where CSR has further large open-cut steaming coal deposits.

Rolleston coal quality

Typical analysis	Raw A-B seams	Raw D seams
Inherent moisture % (air dried)	11.1	12.0
Volatile matter % (air dried)	27.3	30.1
Ash % (air dried)	8.8	6.8
Fixed carbon % (air dried)	52.8	51.1
Sulphur % (air dried)	0.45	0.48
Specific energy (MJ/kg) (air dried)	25.7	26.3
Calorific value (kcal/kg) (air dried)	6100	6250
Hardgrove grindability	50	49
Ash fusion temperature (reducing)		
Hemisphere °C	1280	1280

West Moura (AP 53C)

Brigalow Mines' (Thiess-MIM) **West Moura** coal tenement, just west of Moura township and 10 kilometres from the mine operated by TDM, contains prime quality coking coal, with low ash content and high swell.

Exploratory drilling has indicated reserves exceeding 364 million tonnes in six seams of underground depths of 600 metres to 750 metres.

The **West Moura** prospect is close to rail facilities at Moura, 190 kilometres from Gladstone.

West Moura coal quality

Typical analysis	
Inherent moisture % (air dried)	1.8
Volatile matter % (air dried)	20.0
Ash % (air dried)	8.5
Fixed carbon % (air dried)	69.7
Total sulphur % (air dried)	0.43
CSN	8½-9

Monto

Brigalow Mines Pty Ltd (Thiess-MIM) won a Queensland Government tender for rights to the Monto coal area and is conducting a drilling program to assess the extent of the coal deposit.

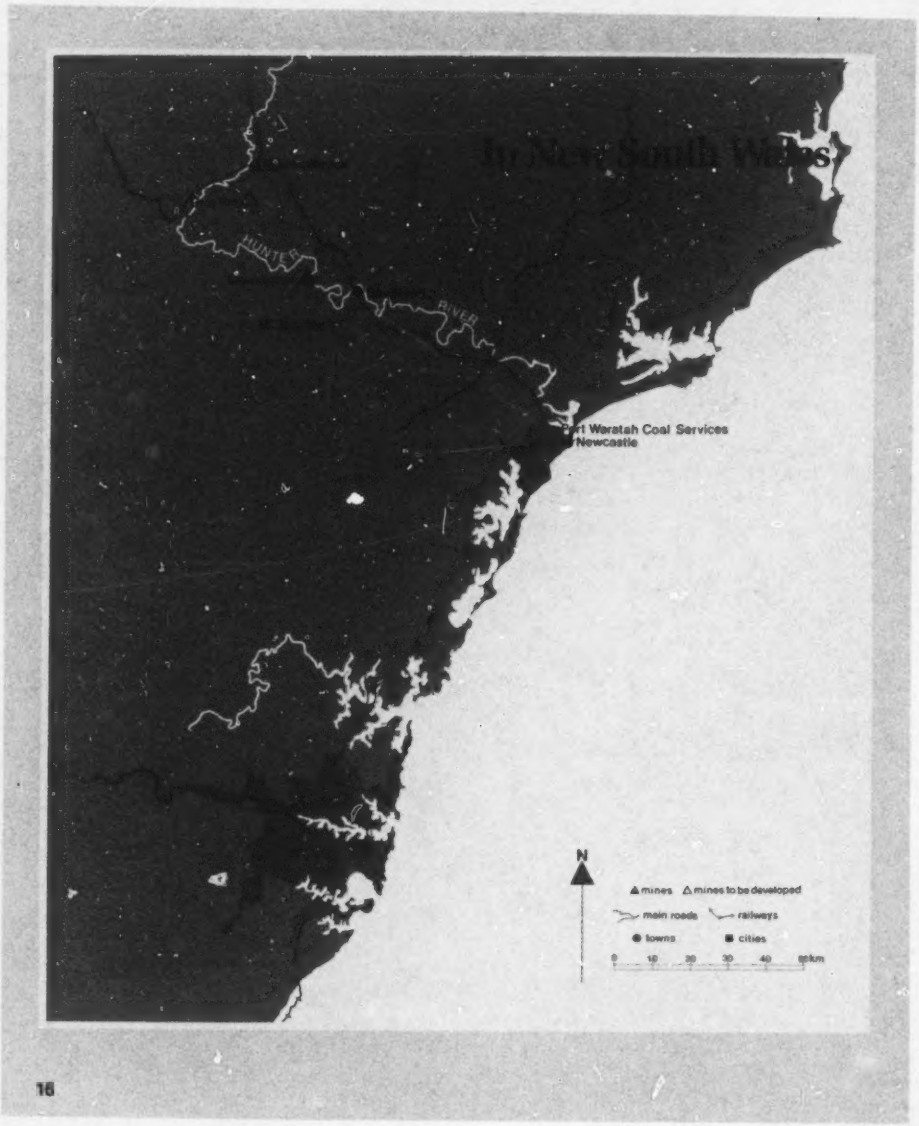
Early exploration results indicate good potential for small tonnages of open-cut coal. Drilling in the late 1960s indicated that the Monto coals were similar to Wandoan coals, with moderate heat values, 10%-12% washed coal ash, and low pollutant contents.

Evaluation is continuing.

Nebo deposits

The **Nebo** field, owned by Thiess Dampier Mitsui Pty Ltd (Thiess 22%), consists of several deposits. Coal quality ranges from semi-anthracite at Bee Creek and South Walker Creek, through weakly coking coal at Kemmis Creek, Walker Creek and Poitrel to hard coking coal at Riverside and Wards Well.

A basic sales agreement for the supply of 3.3 mtpy of coking coal to Japan from the Riverside deposits was concluded in January 1981. First deliveries are scheduled for October 1983.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50km
16

CSR owns one mine, develops another, manages rail and port loading facilities

Buchanan Borehole Collieries Pty Ltd (CSR 100%) has a large mine, **Buchanan Lemington**, in the Hunter Valley near Singleton producing coking and steaming coals. BBC coal is loaded through the rapid train loading facility at Mt Thorley, in which BBC has a 40% interest. CSR manages the facility. Most BBC coal is exported.

The Drayton mine, near Muswellbrook, is being developed by a Coventure. CSR has a 44% interest. It will begin production in 1983.

At the port of Newcastle, CSR, through subsidiaries, has a 33% interest in a large cargo assembly and loading installation, which is being expanded to enable the port to ship 25 mtpy of coal. Plans are also being studied to enable the port to ship in excess of 50 mtpy.

Lemington

Lemington colliery produces coking, briquetting and steaming coal at Warkworth in the Hunter Valley, about 100 kilometres inland from Newcastle.

BBC has been mining coal in the Newcastle and Maitland areas since the 1940s. As these old mines became worked out, BBC transferred men and equipment to **Lemington**.

Commercial operations on this 3800 hectare holding began in 1971. The colliery has been developed to produce clean coking, briquetting and steaming coal at a rate of 2.5 mtpy. BBC mines the Mt Arthur seam, although a number of other seams outcrop in the lease and will be mined in future.

BBC operates open-cut and underground mines which can readily be expanded using the existing plant and infrastructure as a base.

Lemington soft coking coal is a bituminous coal suitable as a high volatile component in a blend of coals for use in coke making.

Modern plant and equipment at **Lemington** ensure that a consistently high quality product is produced to meet contract specifications. Coal quality is closely controlled by regular sampling and testing in a modern professionally staffed laboratory at the mine.

View of one of the modern coal preparation plants at Rucherton Lemington.

A new 1911 2830, 23m³ electric shovel and four 154 tonne trucks are used to remove overburden from the Buchanan Lemington open-cut. Large scrapers, bulldozers and other equipment are also used. This photograph was taken when the shovel was being commissioned.

Lemington coal is widely recognised as having consistent and uniform quality.

Two washing plants are operated with a combined capacity in excess of 800 tonnes of raw coal per hour. Washing capacity could readily be expanded to in excess of 1000 tph.

Lemington coal is transported 18 kilometres by road to the Mt Thorley coal storage and train loading installation, and railed by unit train 85 kilometres to Newcastle. The Mt Thorley rapid train loader installation is a common user facility for coal mined in the Warkworth area. BBC owns 40% of the installation which is managed by CSR. The Mt Thorley installation ensures fast, efficient handling of coal between mine and port. It can load unit trains at 3200 t.p.h.

BBC owns 26.5% of Port Waratah Coal Services whose shiploading facilities at Newcastle are being expanded.

BBC supplies coking coal under long-term contract to steel mills in Japan, Korea and Taiwan.

BBC also has contracts to supply steaming coal for cement manufacture in Japan and Hawaii, for the supply of substantial tonnages of steaming coal to new Japanese power utilities, and for steaming coal destined for Europe and other markets.

Lemington coal quality

Typical analysis	Coking	Steaming
Total moisture % (as received)	8	6-9
Inherent moisture % (air dried)	2.5	3.0
Volatile matter % (air dried)	34-37 (approx	30 min.
Ash % (air dried)	8.5-9.0	12-16
Total sulphur % (air dried)	0.5	0.6
Nitrogen % (dry)		1.6
CSN	½ approx.	1-2
Calorific value (kcal/kg) (air dried)		6600-7000
Hardgrove grindability		50 approx.
Ash fusion temperature (reducing)		
Initial deformation °C		1300
Hemisphere °C		1450 min.
Flow °C		+ 1500
Size		50mm

Much attention is given to rehabilitating mined areas. Considerable success has been achieved at Buchanan Leimgrum as this picture shows: open-cut in foreground and a grassed rehabilitated area in background. When the pastures are firmly established, cattle will be grazed on the rehabilitated area.

State of the modern automatic equipment which monitors air in the underground workings at Buchanan Leimgrum.

A crucible swelling test to determine the grade of coal for coking purposes at BHC's quality control laboratory.

Drayton

Drayton, a new steaming coal mine being developed near Muswellbrook, will begin coal production in 1983, rising to 3.2 mtpy by 1985. The mine could also produce low-grade coking or blending products.

The mine is a Co-venture. Ownership of the Drayton deposit is:

Thiess Bros Pty Limited	44%
The Shell Co of Australia Limited	39%
Australian Mutual Provident Society	7%
Daesung Australia Pty Ltd	2.5%
Hyundai Australia Pty Ltd	2.5%
Mitsui Mining Australia Pty Ltd	3%
Mitsui Coal Development (Australia) Pty Ltd	2%

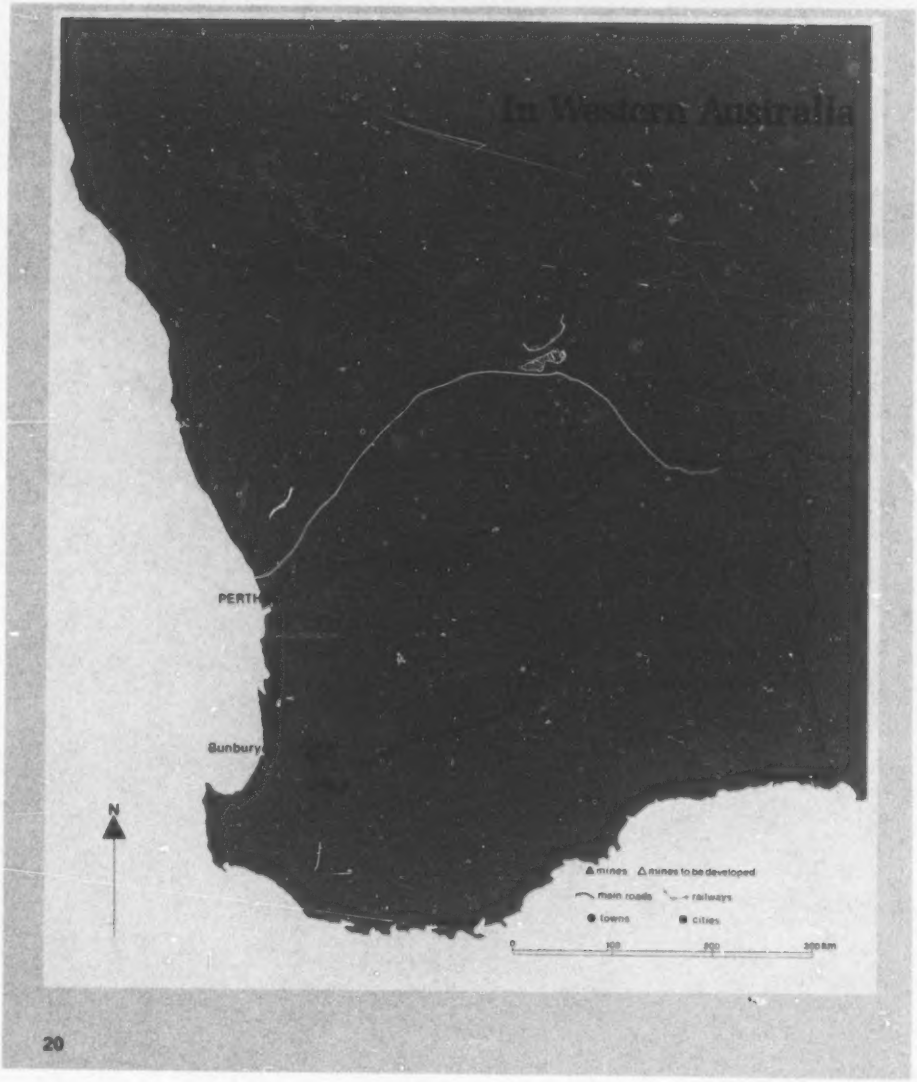
A CSR subsidiary, Drayton Coal Pty Ltd manages the project for the co-venturers.

The coal will be shipped through Newcastle to Japan, Korea, Europe and other markets.

The tonnages will be produced by open-cut methods using shovels, trucks and dragline. It will be a multi-seam operation, and in full production will employ 400 people.

Drayton coal quality

Typical analysis	
Total moisture % (as received)	6
Inherent moisture % (air dried)	1.5
Volatile matter % (air dried)	33
Ash % (air dried)	12
Fixed carbon % (air dried)	48
Total sulphur % (air dried)	0.5
Chlorine % (air dried)	0.04
Nitrogen % (air dried)	1.5
CSN	7
Specific energy (MJ/kg) (air dried)	28-25
Calorific value (kcal/kg) (air dried)	6750
Hardgrove grindability	50
Ash fusion temperature (reducing)	
Initial deformation °C	1250
Hemisphere °C	1300
Flow °C	1350


In Western Australia
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20

CSR mines coal and has access to large reserves

Western Collieries Ltd (CSR 100%) operates open-cut and underground coal mines near Collie about 160 kilometres south of Perth. Current production is 1.4 mt p.y and the company has embarked on an expansion program.

Collie coal is a noncoking, subbituminous coal with low ash, medium volatile content and low sulphur.

The company recently entered into an agreement with the State of Western Australia. The agreement delineates the operating conditions of the company for 42 years beginning on 1 July 1980. Under the agreement the company will provide an overall scheme to develop the coal resource at **Collie** in the most economic and practicable way, and to achieve a balance between open-cut and deep mined coal to satisfy the coal requirement of the State Energy Commission and local industry. All areas mined will be progressively rehabilitated.

The principal customer is the State Energy Commission. Coal is used for power generation in Perth, Kwinana, Bunbury and Muja.

Collie coal is also used for cement manufacture and by some other industries.

The run-of-mine coal is crushed at the mine site and loaded into Westrail wagons for transport to customers. Some coal transport to smaller customers is by road haulage.

The coal produced does not require additional processing. The supply, however, of selective gradings is under review.

Measured and indicated reserves exceed 450 million tonnes. Inferred tonnages are large.

The company plans to begin work soon on two new coal mines in the Collie area — an open-cut near Muja and an underground mine between Collie and Muja.

Additional exploration drilling is expected to prove increased reserves in these two categories.

In addition to the reserves in the Collie Basin, WCL has coal mining leases in adjacent areas including the Wilga Basin about 25 kilometres to the south.

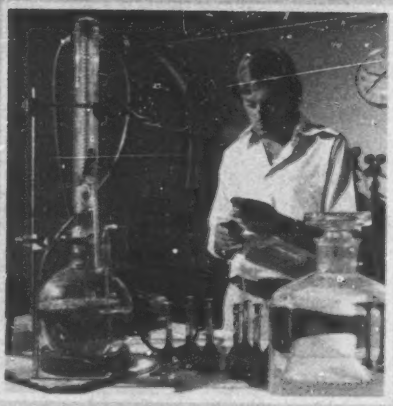
The company is also exploring for coal in the north-western and southern parts of the State. The activity in the southern part of the State has uncovered significant lignite deposits north of Esperance, and feasibility studies are being made to determine the economic viability of these deposits.

Western Collieries & Dampier Pty Ltd (WCL 50%, Dampier Mining 50%) has additional coal reserves with viable open-cut mining potential adjacent to the existing WCL leases in the Collie Basin.

Overburden being removed at a Collie open-cut with exposed coal in the foreground.

Collie coal quality

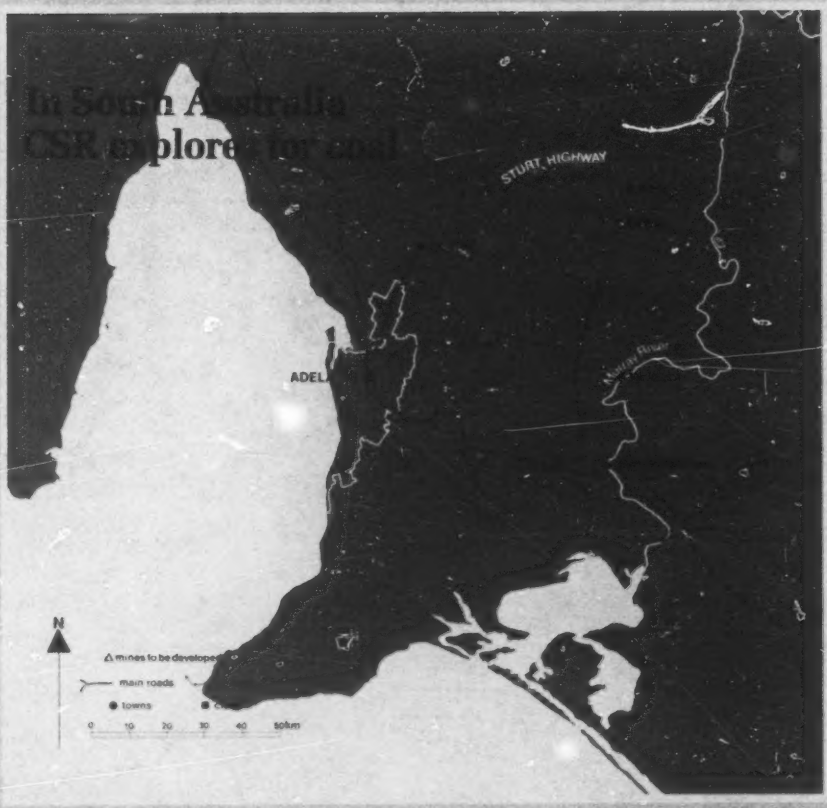
Typical analysis	Under-ground	Open-cut
Total moisture % (as received)	26	26.5
Inherent moisture % (air dried)	25	25-26
Volatile matter % (air dried)	28	25-27
Ash % (air dried)	4	5.2-6.8
Fixed carbon % (air dried)	43	43
Total sulphur % (air dried)	0.5	0.3
CSN	0	0
Specific energy (MJ/kg)	21.3	20.7
Calorific value (kcal/kg)	5070	4930
Hardgrove grindability	50-70	50-70
Ash fusion temperature (reducing)		
Initial deformation °C	1270	1410-1570
Hemisphere °C	1300	1460-1600
Flow °C	1340	1510-1620



Continuous mining machine in operation at a Collie underground mine.

A unit coal train being loaded at Collie. WCL manages another crushing and loading installation near Collie for the State Energy Commission.

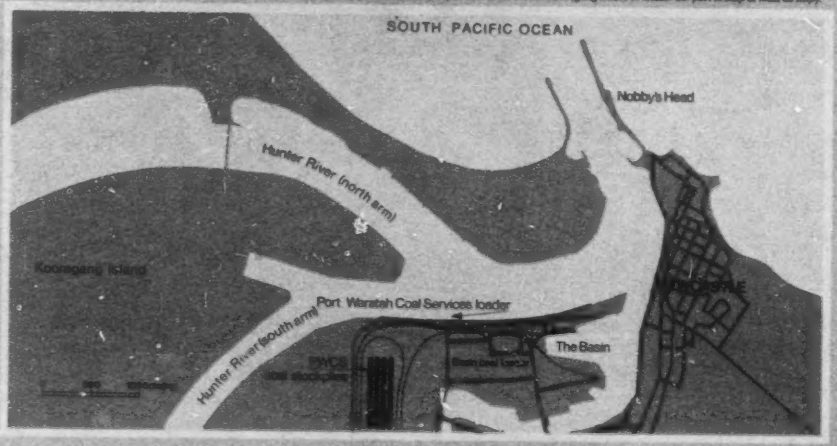
Part of the modern well-equipped laboratory at the WCL office in Collie.



Mannum

Brown coal reserves totalling 58 million tonnes of measured reserves and 154 million tonnes of indicated reserves are contained in the Sedan and Anna deposits, located 40km and 50km respectively north of the town of Mannum. Active exploration of this CSR Energy Division project area is continuing.

The port of Newcastle showing the Port Waratah Coal Services installation in the foreground, the Maritime Services Board installation top right and the entrance to the harbour. The harbour is being dredged to take 120 000 dwt vessels. The PWCS installation is now being expanded. A third facility is planned to be built at Kooragang Island to enable the port to ship at least 60 mtpy.



24

Shipping facilities — three ports will ship CSR coal

Three large ports will ship CSR coal from present and potential mines:

- Newcastle, New South Wales
- Gladstone, Queensland
- Hay Point, Queensland

Newcastle

The coal from the Hunter Valley is shipped through Newcastle, where CSR manages and partly owns a cargo assembly and loading installation. Newcastle has two cargo assembly and loading installations with capacity to ship 16 million tonnes per year.

Port Waratah Coal Services (CSR through subsidiaries 33⅓%) owns the newest and largest of the installations.

PWCS, which began operating in 1977, has two shiploaders. PWCS is increasing the capacity of its installation, including construction of a second berth and a third shiploader, to enable the port to ship 18 mtpy in early 1981 and 25 mtpy by the end of 1982. The channel is being deepened to 15.2 metres to take up to 120 000 dwt vessels by late 1982. The channel now dredged to 12.5 metres can take Panamax vessels of 60 000 dwt. A third coal loader will be built in stages on Kooragang Island. The first stage is expected to begin operation in 1984.

Gladstone

The port of Gladstone has three coal loading facilities — Auckland Point, Barney Point and Clinton Estate.

The most recent coal loading installation is that at Clinton Estate and it can load vessels up to 60 000 dwt at a rate of 4000 tph. The installation has an annual capacity of 10-12 million tonnes, and could readily be doubled in size.

GLADSTONE COAL LOADING INSTALLATIONS

	Stockpile capacity (tonnes)	Loading capacity (tonnes)	Loading rate (tph)	Maximum vessel size (dwt)
Clinton Estate	1200	10	4000	60 000
Barney Point	440	8	2000	60 000
Auckland Point	200	6	1600	35 000

A view of the port of Gladstone with the new Clinton Estate installation in the foreground and Auckland Point and Barney Point in the distance.

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This picture taken from the wharf of the new coal storage and loading installation at Clinton Estate, Clarkstone, shows the Auckland F. 6st loader (middle distance) and the Barney Point installation (far left). The Clinton Estate installation has been designed so that it can be expanded significantly.

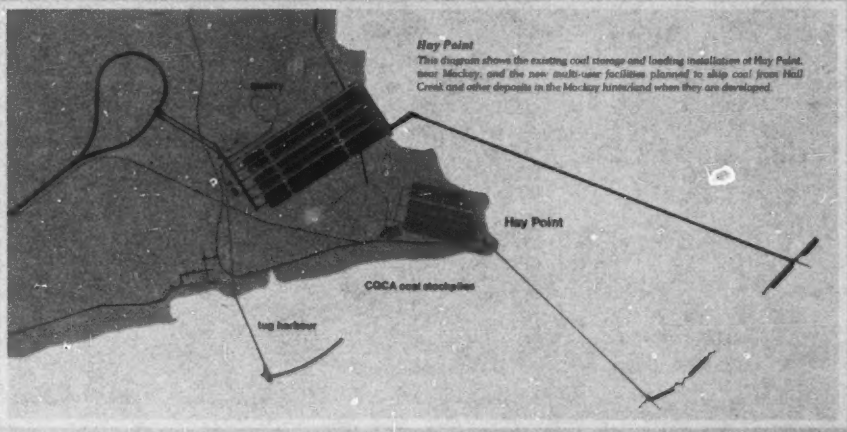
Vessels enter the port via an entrance channel 10 kilometres long with a bottom width of 163 metres and dredged to a depth of 10.36 metres at low water ordinary spring tides. The port will soon be dredged to enable Clinton Estate to receive 120 000 dwt vessels.

Hay Point

Coal from the Hail Creek, Lake Elphinstone and Nebo deposits will be shipped through a second coal storage and loading installation at Hay Point.

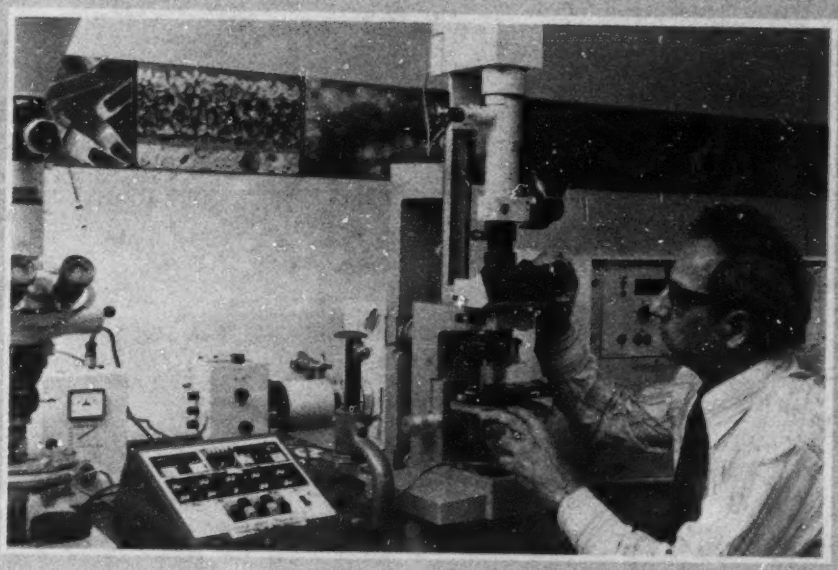
The first stage of the multi-user installation, to be built by the Queensland Government, will have capacity of about 15 mtpy, loading 150 000 dwt vessels at 6000 tph.

The loader will be about 4 kilometres offshore.



Hay Point

This diagram shows the existing coal storage and loading installation at Hay Point, near Mackay, and the new multi-user facilities planned to ship coal from Hail Creek and other deposits in the Mackay hinterland when they are developed.



Microscope used to measure the reflectance of coal

Research

As well as the routine investigations in laboratories at its mine sites, CSR has since 1974, maintained a coal research group at its Rosewille research laboratories in Sydney. The work assists in the development and marketing of CSR coal and exploring future energy technologies.

Currently work is underway in a number of broad programs:

Coal evaluation — Facilities are installed for testing and analysis of coking and steaming coals, carbonisation and coke reactivity. One research program is correlating coke quality parameters with original coal properties and providing data on the role of CSR coals in blends for coke making.

Coal hydrogenation — An hydrogenation laboratory is well established. Emphasis of current coal hydrogenation research is on:

- assessment of the potential of Australian coals for production of automotive fuels
- investigation of the use of waste and natural materials as disposable catalysts in coal hydrogenation
- investigation of aspects of conversion processes shown by feasibility studies to be of particular relevance.

Batch autoclave testing to compare Australian coals is being complemented by continuous scale testing at outside laboratories.

Work on screening a wide range of iron-based disposable catalysts is under way. Those materials which offer the best prospects will be examined in more detail in subsequent stages of the program.

Development

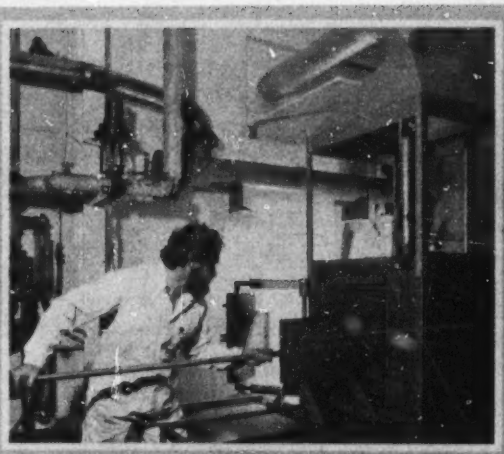
Coal conversion — CSR is also involved in joint feasibility studies for coal conversion.

CSR and Mitsui SRC Development Company Ltd have signed an agreement to carry out a joint evaluation study of the commercial production of solvent refined coal and liquid fuels from Latrobe Valley brown coal. The study is targetted for completion by 30 June 1982.

The plant and associated facilities would take up to four years to construct and could be in commercial production as early as 1987 if a decision to proceed with development were made in 1983.

The equity interests in the project are 50% CSR and 50% Mitsui SRC Development Company Ltd.

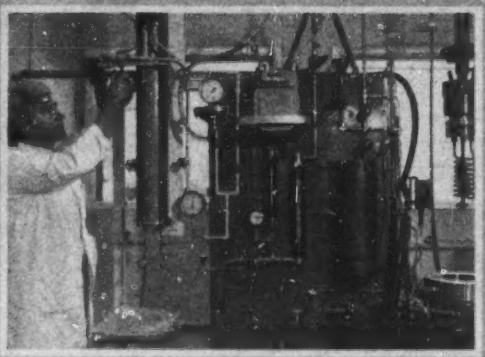
CSR is also investigating the possibility of participating in other feasibility studies for the conversion of coal to liquid fuels.



Above: Coking qualities of coal and various mixes of coals are tested in this 7 kg coke oven.

Left: Oil from coal being distilled to separate the lighter from the heavier fractions. At CSIR Research Laboratories a wiped-film still is used.

Below: This apparatus is used to assess the suitability of a coal for the production of fuel by hydrogenation.



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Back cover: Removal of overburden at Buchanan Lemington open-cut near Singleton, NSW.

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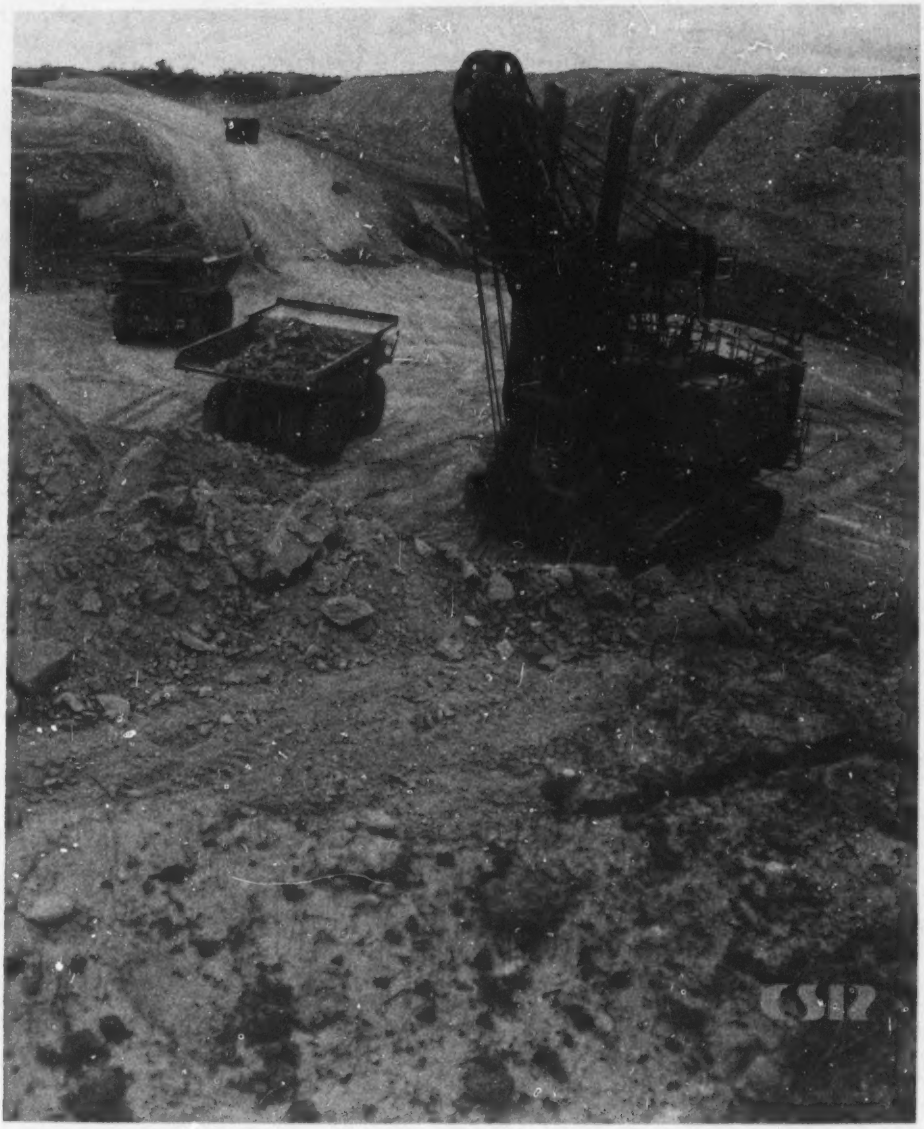
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APPENDIX F

New Zealand Energy Plan Report

The group made available a 1982 energy plan report by the Ministry of Energy for Fiscal Year ending March 31, 1982, and the report of the Department of Scientific and Industrial Research for Fiscal Year ending March 31, 1982. This section deals with the features of the New Zealand energy plan and some discussion of the New Zealand energy report. The energy plan is based generally on reducing oil imports and to the greatest extent possible utilizing domestic resources to do this. The energy plan is submitted annually to the House of Representatives, and the delegation was given copies of the 1982 plan. The plan is very detailed, containing a review of the previous year's plan, discussion of pricing, demand forecasting, liquid fuel situation, particularly in terms of indigenous fuels, electricity planning, a discussion of the natural gas situation, and also includes a discussion on the coal supply situation, resource requirements in terms of people needed for the infrastructure, R. & D., and long-term energy transfer. It is a very detailed energy plan, in fact, considerably more detailed then the annual report required by law which the Secretary of Energy submits to the U.S. Congress.

The use of transportation fuels has been somewhat flat in New Zealand since 1976–1977 but the forecast is for some significant growth in such use and various percentage increases are chosen for different sector use such as aviation fuels, oil, diesel, etc. Industrial and commercial energy forecasts for electricity use chiefly from hydro, coal, liquid fuels and gas are similarly expected to increase significantly over the next twenty years. However, it should be noted that peak use in these areas in the last decade was in 1976–1977, and since then overall consumption has dropped off measurably. The energy GNP/ratio for New Zealand is presently about ⅔ of that of the United States and they are forecasting an increase in this factor by 1990 such that it would roughly equal the U.S. figure of .6 in tons of oil equivalent per U.S. dollar. They are also projecting, apparently based on increased conservation, that the U.S. consumer energy/GNP ratio would be just about the same by 1990 which would require a continued decrease at roughly a linear rate in that quantity which may be very optimistic.

In terms of future consumption, New Zealanders are projecting significant increases in use by wood, metal and other industry project areas, as well as significant increases in industrial/commercial sectors and a smaller but still measurable increase in the use of the transportation sector. They are projecting a dramatic increase in the use of natural gas by the year 2000. The New Zealand energy plan allows for a significant expansion of 3,000 gigawatts electric in the industrial sector, specifically to support aluminum smelting and this plus an-

ticipated growth in other areas would mean a major increase in electrical use over the next ten years. They are anticipating a three-fold increase in natural gas use and modest but measureable increases in liquid fuels including petroleum and LPG. The New Zealanders are expecting significant increases in the use of domestic coal, yet this is not a major factor in supplying the amounts of energy they need over the next two decades. Their plans for hydro involve a 35% increase in electrical capacity while hydro is already providing 85% of the electricity. The increase, however, will amount to complete exploitation of the hydro so far as they see it. It should also be noted that although geothermal is a significant long-standing program to the New Zealanders, even the tripling of its capacity over the next few years will not make it a major contributor to the electric supply. In the electrical sectors they have done a series of load forecasts including high, mid-range and low, including and excluding the 3,000 megawatt capacity for the aluminum smelting activity. It should be noted that is 3 terawatt hours electric energy per year for the 3 gigawatts capacity addition mentioned.

New Zealand is in a transition toward more thermal fuel use for electricity from the present hydro base. In a dry year, the hydro contribution can drop by as much as 13% of the electricity supplied and the switch to thermal fuel provides a better control on baseload capacity. The slowing of the progress of getting the Huntley mine to provide coal for new power stations is generally delaying this overall contribution, and it means in the meantime that the New Zealanders will depend more on open pit mining. Although the increase in coal use for electric power generation is to be significant, it would still not make a major difference within this decade. The New Zealanders are looking to exploit the resources of South Island lignite in the next decade or so as well. Overall, they are looking for a factor of 20 increase in coal useage for electricity under at least one scenario by 1996–1997, however, this would still correspond to total coal use of only 20% of the hydroelectric and geothermal contribution which is chiefly hydroelectric. Under their case B electricity development plan, the hydro and geothermal contribution would be significantly less than in case A, but the coal use would be nearly the same as in case A corresponding to a larger percentage contribution of coal to electricity by 1996–1997. In the gase sector, New Zealand is forecasting an almost four-fold increase in gas useage over the next 15 years with over a third of this coming from their major methanol, ammonia, urea and synthetic petroleum projects including gasoline from natural gas. They will not be using gas for electric power generation over the next 15 years beyond employing certain existing stations which they have on-line where they prefer to burn gas rather than oil. Since all their gas is presently found off the North Island, there is considerable discussion of the transportation of that natural gas to the South Island over the next 15 years. The average gas use by the electricity sector is restricted after the year 1987 so that these supplies to the existing stations fueled by gas could be impacted. There was considerable discussion in the energy plan of the range of uncertainties surrounding energy forecasting whether it be done in terms of high, low and intermediate cases or various scenarios such as the inclusion of the 3,000

terawatt hour electrical supply for smelting aluminum. On the economic side there was also considerable discussion of the merits of choosing various discount rates and the sensitivity of energy costs under these choices.

The report of the Ministry of Energy presented to the House of Representatives for the year ending 31 March 1982 is very extensive particularly with respect to financial statement and tables drawing results, etc. It also has some programmatic content including discussion of regulatory matters with respect to energy titlement projects. The report goes into extensive detail. For example, accidents might occur under different facets of energy development segments (e.g., quarry mining) which are described with specifics. It is a source of statistics on the level of various activities: coal mining; minerals extraction; energy pricing; etc.; as well as a financial statement of various aspects on the Ministry of Energy's activities including revenues from electricity accounts, other auditing reports, geothermal development status, R&D funding breakout, etc.

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